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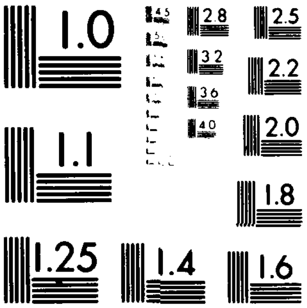
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ANALYSIS OF PROJECT EXCEDE II CIRCULAR VARIABLE FILTER SPECTROMETER DATA

William F. Grieder
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EXCEDE II is the fourth in a series of research experiments conducted by Air Force Geophysics Laboratory (AFGL) to study the infrared emission processes induced by rocketborne electron accelerators. The excitation of the upper atmosphere by the electron beam simulates aurora induced processes but provides the advantage that the dosing is more precisely quantified than in the natural auroral case. In addition, optical/infrared instruments carried

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on-board the same payload with the accelerator provide controlled viewing geometry of the induced emissions and measurements do not suffer from long path atmospheric attenuation as would be the case for some ground based observations.

The EXCEDE II payload was launched from Pad 4, Poker Flat Research Range, Alaska on 25 October 1979 at 0546:40 UT hours. The payload reached a ~128 km apogee at ~187 seconds after launch. Although some difficulties were encountered with electron gun arcing the experiment was successful and data were obtained for gun on and off conditions throughout the flight (O'Neil 1980).

The primary purpose of this report is to describe in detail the techniques used to process and analyze the data measured with the two CVF spectrometers on the EXCEDE II payload. Part A of the report deals with the LN_2 CVF spectrometer (designated NS-6-4), Part B describes techniques employed with the LH CVF spectrometer (designated HS-3B-1) and Part C presents recommendations for final data processing of the HS-3B-1 CVF.

PREFACE

EXCEDE II is an Air Force Geophysics (AFGL) research program to study auroral infrared emission processes using a rocketborne electron accelerator to generate artificial aurorae. The effort is sponsored by Defense Nuclear Agency (DNA). The EXCEDE concept was originally proposed by Dr. A. T. Stair of AFGL in 1971 and since that time four successful experiments have been conducted. These experiments have been directed by Mr. Robert O'Neil also of AFGL.

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INTRODUCTION

EXCEDE II is the fourth in a series of research experiments conducted by Air Force Geophysics Laboratory (AFGL) to study the infrared emission processes induced by rocketborne electron accelerators. The excitation of the upper atmosphere by the electron beam simulates aurora induced processes but provides the advantage that the dosing is more precisely quantified than in the natural auroral case. In addition, optical/infrared instruments carried on-board the same payload with the accelerator provide controlled viewing geometry of the induced emissions and measurements do not suffer from long path atmospheric attenuation as would be the case for some ground based observations. The other EXCEDE experiment programs were PRECEDE, EXCEDE II Test, and EXCEDE: SWIR (O'Neil 1976).

The EXCEDE II payload incorporated four electron guns programmed to function in different combinations and capable of producing a 10 ampere electron beam when activated simultaneously. The optical/infrared instruments on-board the payload were primarily for measuring spectral data and included; liquid nitrogen (LN_2) interferometer, LN_2 circular variable filter (CVF) spectrometer, liquid helium (LHe) CVF spectrometer, LN_2 radiometer, ultraviolet/visible spectrometer, a camera and five photometer units. In addition the payload contained several ionospheric probes and diagnostic sensors to measure ion and electron densities and fields. The optical/infrared instruments viewed the beam region throughout the flight at a stablized zenith angle to local vertical of 45°.

The EXCEDE II payload was launched from Pad 4, Poker Flat Research Range, Alaska on 25 October 1979 at 0546:40 UT hours. The payload reached a ~128 km apogee at ~187 seconds after launch. Although some difficulties were encountered with electron gun arcing the experiment was successful and data were obtained for gun on and off conditions throughout the flight (O'Neil 1980).

The primary purpose of this report is to describe in detail the techniques used to process and analyze the data measured with the two CVF spectrometers on the EXCEDE II payload. Part A of the report deals with the LN_2 CVF spectrometer (designated NS-6-4), Part B describes techniques employed with the LH CVF spectrometer (designated HS-3B-1) and Part C presents recommendations for final data processing of the HS-3B-1 CVF. Processed data for this instrument presented in this report is preliminary.

PART A

LN_2 CVF SPECTROMETER

2.0 Description of Nitrogen CVF(NS-6-4).

Construction details and method of operation of the rocketborne CVF spectrometer have been reported by Rogers, 1976, and Wyatt, 1978. The CVF instruments were fabricated by the Electrodynamics Laboratory of Utah State University. In brief the monochromator portion of the sensor consists of two 180-degree circular variable (wedge) filters mounted so that the bandpass interference layers rotate just above the detector field stop which performs the function of a spectrometer slit (see Figure 2.0-1). The spectrometer scans a continuous wavelength region depending on which half of the filter is rotating over the detector. Spectral resolution ($\Delta\lambda$) depends on slit width and f number. Pertinent figures of merit for the EXCEDE NS-6-4 instrument are given in Table 2.0-1.

Two important parameters for CVF data processing are the start times of the beginning of each spectral scan and the speed of rotation of the CVF. Two assumptions made are that the speed of rotation is constant throughout the flight and that the wavelength of radiation being measured is linearly proportional to time (or filter position). One consequence of this CVF mode of operation is that since the payload is constantly changing altitude the spectra obtained are associated with different altitudes. Each part of a spectral scan is for a different altitude and thus altitude must be computed for every spectral data point.

Table 2.0-1

PERFORMANCE PARAMETERS
FOR CVF NS-6-4

Wavelength Coverage (μm)	2.1 to 3.5 , 3.25 to 5.4
Spectral Resolution (μm)	0.05 @ 2.7 μm , 0.08 @ 4.3 μm
Detector Type	InSb
NESR ($w\text{-}cm^{-2}\text{-}sr^{-1}\text{-}\mu m^{-1}$)	2.4×10^{-10}*
Dynamic Range	2×10^{5} *
Half Angle Field of View (deg)	1.871
Spectral Scan Rate	~2/sec

*reference 5

2.1 NS-6-4 Calibration Parameters

Radiance and wavelength calibrations for the NS-6-4 CVF were accomplished by both AFGL and Utah State University (Wyath 1978) prior to rocket launch. These calibrations showed good agreement so those of AFGL were used for this work.

2.1.1 Wavelength Calibration

The NS-6-4 CVF had two halves designated long (subscript 1) and short (designated s) which refers to long wavelength and short wavelength. The AFGL calibration equations were adjusted using the data and known emission features such as the CO_2 (ν_3) peak at 4.28μm. The appropriate equations are

$$\lambda_n(s) = 1.693 + (3.916 \times 10^{-2}) P_n \qquad (2\text{-}1)$$

$$6.79 < P_n < 46.37 \, ,$$

$$P_n = \frac{n}{N} \times 100 \qquad (2\text{-}2)$$

Where n = number of the data point in the scan
N = Total number of data points in the scan
P_n= percentage of n data point of total scan

For the long half of the filter.

$$\lambda_{n(\ell)} = -0.292 + (5.860 \times 10^{-2}) P_n \qquad (2\text{-}3)$$

$$59.42 < P_n < 97.82$$

In the NS-6-4 the short half of the filter was scanned first.

2.1.2 Radiance Calibration

Radiance computations were done in units of megarayleighs per micron (MR/μm) or brightness (B) since these units were used in calibration and permit direct physical interpretation of the results. In some cases the term "existence" is also used (Wyath 1978). To convert telemetry volts (V_{TM}) contained in the data channels the following calibration equations apply

$$B = M_{(col)N} \, F_{V_{TM}})/\Delta\lambda \text{ megarayleighs/micron} \qquad (2.4)$$

where the resolution ($\Delta\lambda$) is given by

$$\Delta\lambda_s = 0.013 + (1.4875 \times 10^{-2})\lambda$$

$$\Delta\lambda_{\ell} = 0.0256 + (1.20 \times 10^{-2})\lambda$$

and

$$\text{HIGH GAIN } F_{(V_{TM})} = 6.5 \times 10^{-3}\, V_{TM}\,, \quad V_{TM} \leq 10 \text{ volts} \qquad (2.6)$$

$$\text{LOW GAIN} \begin{cases} F_{(V_{TM})} = 0.556\, V_{TM} & , \; V_{TM} \leq 1.8 \text{ volts} \\ F_{(V_{TM})} = 0.5199\, V_{TM}^{1.11277} & , \; 1.8 < V_{TM} \leq 10 \text{ volts} \end{cases} \qquad (2.7)$$

The values of $M_{(col)N}$ depends upon wavelength and are given in Table 2.1-1. $M_{(col)N}$ are set to zero for values of λ outside the tabled limits. The AFGL calibration was truncated based on data at 2.10, 3.50 and 3.25, 5.40 microns. These data are plotted in Figure 2.1-1 and show the wavelength overlap around 3.25 microns. This fact provided a convenient region to check consistency in calibration between the long and short wavelength filter halves. Notice the brightness scale on Figure 2.1-1 is 10^3 MR/μm. Thus the calibration peak at 2.95 μm is 8228 MR/μm.

2.2 Telemetry Signal

The EXCEDE II employed four telemetry (TM) links with ground receiving and recording systems. All data for the CVF instruments was contained in TM Link 3 tape (recorder 2 original) track 5 of the range tape. IRIG B time code to be used with these data was on track 3 station MUX (the normal 13 IRIG B track was reported to be spotty.) The data was pulse code modulated (PCM) which is described by Space Data Corporation (1979). Data for each instrument coded in several PCM words was "read", reformatted and recorded on separate digital tapes along with time in a format compatible with the AFGL CDC 6600 computer.

Flight data was digitized from T+40 sec (0457:20 UT hours) to T+340 sec (0553:50 UT) which was loss of signal. Data for the NS-6-4 CVF instrument were in words 2 and 26, 3 and 27, and 4 and 28 of all frames. Words 2 and 26 are high gain, 3 and 27 are low gain and 4 and 28 are the reference. The high and low gain contain the spectra and the reference contains the start pulse of each spectral scan, in addition to other wavelength reference pulses (of lower amplitude than the

TABLE 2.1-1

$M(col)_N$ vs. Wavelength NS 6-4

λ µm	$M(col)_N$ MR	λ µm	$M(col)_N$ MR	λ	$M(col)_N$ MR
	Short Wavelength Half			**Long Wavelength Half**	
2.10	3.03×10^2	3.25	3.01×10^2	4.85	2.44×10^2
2.15	3.03	3.30	2.93	4.90	2.38
2.20	2.95	3.35	2.91	4.95	2.35
2.25	2.77	3.40	2.95	5.00	2.32
2.30	2.56	3.45	2.88	5.05	2.31
2.35	2.40	3.50	2.84	5.10	2.29
2.40	2.28	3.55	2.81	5.15	2.28
2.45	2.24	3.60	2.83	5.20	2.28
2.50	2.27	3.65	2.85	5.25	2.30
2.55	2.38	3.70	2.88	5.30	2.35
2.60	2.51	3.75	2.93	5.35	2.48
2.65	2.60	3.80	2.98	5.40	2.83
2.70	2.94	3.85	3.00		
2.75	3.60	3.90	3.01		
2.80	4.01	3.95	3.03		
2.85	4.30	4.00	3.05		
2.90	4.57	4.05	3.05		
2.95	4.68	4.10	3.03		
3.00	4.43	4.15	3.09		
3.05	4.15	4.20	3.14		
3.10	3.81	4.25	3.08		
3.15	3.42	4.30	2.97		
3.20	3.16	4.35	2.91		
3.25	2.91	4.40	2.85		
3.30	2.74	4.45	2.83		
3.35	2.66	4.50	2.76		
3.40	2.69	4.55	2.74		
3.45	2.72	4.60	2.72		
3.50	2.79	4.65	2.70		
		4.70	2.63		
		4.75	2.57		
		4.80	2.51×10^2		

start pulse) that were not used in the data processing. A review of these words showed a one data point lag in the start pulses between words 4 and 27. To avoid this confusion only word 4 was used to locate the scan start times.

Criteria for scan start was the first data point of value 20 counts or less following the peak ($>$900 counts) of the start pulse. A listing of these start times (with other parameters is given in Appendix A).

The high and low gain spectral data were contained in words 2 +26 and 3+27 were converted to TM volts using the equation

$$V_{TM} = \frac{C-12}{100} \qquad (2-8)$$

Where C = number of counts (Space Data Corp. 1979).

2.3 Data Processing

The CDC digital tapes described in section 2.2 were processed using the scan start times (Appendix A) and the calibration equations to form a data base of one record per spectral scan. The seven parameters per data sample are

Parameter	Content
1	wavelength - microns
2	time after launch - seconds
3	altitude - km
4	high gain TM voltage - volts
5	high gain brightness - MR/μm
6	low gain TM voltage - volts
7	low gain brightness - MR/μm

These parameters were computed for every data point. Payload altitude was computed with an eighth order fit to radar range data and utilized time after launch as the independent variable. The trajectory equation and coefficients are

$$h = a_0 + \sum_{i=1}^{i=8} a_i T^i$$

a_0 = -.539640306E+02

a_1 = .2741505348E+01

a_2 = -.2947169205E-01

a_3 = .3475921337E-03

a_4 = -.2907943273E-05

a_5 = .1480695146E-07

a_6 = -.4493696965E-10

a_7 = .7464427803E-13

a_8 = -.5216526696E-16

where

h = payload altitude - km

T = time after launch - seconds

The brightness data was plotted on semilog scale for each gain as a function of wavelength and altitude. All scans were plotted. The data was also plotted on a linear scale but otherwise in the same format. A sample brightness spectra is shown in Figure 2.3-1. The data shows Wu Benesch spectra between 2 and 3 microns and the prominent 4.28 micron CO_2. In the 3.4 micron region the filter short and long half responses overlap and indicates good agreement in the absolute brightness calibration. Notice that every spectral data point occurs at a different altitude because of payload motion as reported previously. Below 250 MR/μm the presence of noise equivalent to 1 count in the onboard digitization process is evident. This effect is described in the next section of this report.

2.3-1 Error Analysis

For the NS-6 CVF the uncertainty in establishing counts is 1 count, therefore from Equation (2-8)

$$\min \Delta V = 0.01 \text{ volts}$$

Thus for high and low gain $F(V_{TM})$ is 6.5×10^{-5} and 5.56×10^{-3} respectively see Equations (2-6) and (2-7). For the short half the worst case uncertainty occurs at 2.95 micros (see Figure 2.1-1) and the uncertainty for high gain is 0.53 MR/μm. For the long half the worst case high and low gain uncertainty occur at 3.25 microns and are .03 MR/μm and 24.7 MR/μm respectively. These values represent error bars (+ and -) of the measured data and in general are given by

$$\Delta B = \pm \frac{M_{(col)}}{\Delta\lambda} F(.01) \qquad (2\text{-}10)$$

where

$F_{(.01)}$ = factor for V_{TM} = 0.01 volts

$\frac{M_{(col)}}{\Delta\lambda}$ = Figure 2.1-1.

The percentage error represented by the one error count depends only on the number of counts measured, viz,

$$\varepsilon = \frac{\Delta B}{B} \times 100 = \frac{1}{C-12} \times 100\% \tag{2-11}$$

It is desirable to merge the low gain data with the high gain data when the high gain saturates. However as will be shown below problems of accuracy are incurred. High and low gain volts are related through the electrons gain factor G as follows

$$V_H = GV_L \tag{2-12}$$

where

G = gain factor

V_H = high gain volts

V_L = low gain volts

From Equation (1) the high gain counts (C_H) and low gain counts (C_L) are substituted in Equation (10).

$$C_L = \frac{C_H + 12(G-1)}{G} \simeq \frac{C_H}{G} + 12 \tag{2-13}$$

If the switch from high gain to low gain is done using equation (11) the error due to 1 count at the switch over to low gain is found by substituting (11) in (9) which yields

$$\varepsilon_{switch} = \frac{G}{C_H} \times 100 \tag{2-14}$$

If we choose to switch at C_H = 900 the error after the switch due to 1 count uncertainty is 8.3% assuming G = 75 where just prior to the switch the error is only 0.11% due to 1 count uncertainty. This discrepancy at the switchover point is undesirable and consequently the high and low gain data was not merged but treated separately.

2.3.2 Data Bases

In view of the incompatibility of high gain low gain data merge described above, no attempt was made to merge the two channels. Instead high and low gain channels were used to generate individual data bases. Samples from these data bases are given in Appendix D. High gain channels show the effects of one count digitization noise when the guns (accelerators) are not in operation, superimposed on a background signal caused by a small offset voltage in the system (see scan 116, 119, 121, etc.). The spectral structure of the background mirrors the system responsivity characteristic (see Figure 2.1-1). In the region of 100 km (scans 139, 153, 159) there appears to be a substantial signal enhancement probably due to instrument covers floating through the CVF field of view.

Periods for gun-on operation are given in Table 2.3-1. The correlation of signal enhancement with periods of gun-on operation can be observed by inspecting scans 237, 276, etc.

Table 2.3-1

ACCELERATOR OPERATION

Gun On Time* (seconds)	Gun Off Time* (seconds)	Gun Number
115.495	116.052	1
135.845	136.104	4
138.651	139.695	4
141.636	144.148	4
153.254	156.745	4
159.277	161.547	4
173.220	174.538	4
176.485	176.728	4
179.274	100.335	4
188.113	191.242	4
193.916	197.811	4
208.083	209.383	4
211.335	212.549	4
213.885	214.625	3
222.984	226.814	4
228.779	232.681	4
240.424	240.325	3
243.302	244.273	3
243.032	244.285	4
248.724	248.928	3
246.246	250.139	4
257.881	281.735	3
257.885	261.743	4
283.607	263.925	1
263.704	264.331	4
263.704	266.7	3
266.859	267.620	4
277.882	279.193	1
275.363	279.224	3

Table 2.3-1 (Cont.)

Gun On Time* (seconds)	Gun Off Time* (seconds)	Gun Number
275.367	279.228	4
281.083	282.047	1
281.189	282.750	4
234.525	235.032	1
283.684	285.088	3
286.929	290.859	1
292.863	293.236	4
292.759	244.156	1
298.149	296.72	2
292.863	296.723	3
298.581	298.795	1

PART B

H_e CVF SPECTROMETER

3.0 Description of Helium CVF (HS-3B-1)

The HS-3B-1 CVF (see specifications Table 3.0-1) is basically similar to the nitrogen CVF except a tuning fork optical chopper was added that periodically interupted the incoming radiation to the sensor at a frequency of approximately 106 Hz. The sensor electrical output was filtered with an electronic filter centered at 100 Hz and passband approximately 50 Hz wide. This technique produces an amplitude modulated waveform whose envelope contained the observed spectral radiance information. Both a high and low gain channel were included for the modulated signal. The basic problem in processing the Helium CVF data was to demodulate and rectify the output signal then apply calibration factors to deduce the observed spectra in MR/μm.

Also unlike the Nitrogen CVF the long half of the HS-3B-1 CVF consisted of two filter segments in order to achieve the long wavelength response. However since the long half wavelength calibration applied throughout the spectral region the brightness calibrations at the joint wavelengths was simply set to zero and the long half of the CVF was treated as if it were continuo.

3.1 Calibration Parameters

Radiance and wavelength calibrations were accomplished by both AFGL (Condron and Austin, private communications) and USU (Wyatt, 1979). Agreement of these data was adequate however the AFGL calibration data were used because the information was more detailed. In addition the AFGL wavelength data was also slightly modified (shifted) to agree with certain known emission features in the data such as CO_2 14.97 μm. However the shift was less than a wavelength

Table 3.0-1

PERFORMANCE PARAMETERS FOR CVF HS-3B-1

Wavelength Coverage (μm)	3.9 to 6.8 , 12.7 to 22.3
Spectral Resolution (μm)	0.16 @ 5.3 μm , 0.4 @ 15 μm
Detector Type	Si : (As)
NESR ($w\text{-}cm^{-2}\text{-}sr^{-1}\mu m^{-1}$)	1.08×10^{-11}*
Dynamic Range	8×10^{4}*
Half Angle Field of View (deg)	1.973
Spectral Scan Rate	~0.8/sec

*reference 7

resolution element of the instrument.

3.1.1 Wavelength Calibration

The HS-3B-1 filter halves are designated long wavelength (subscript ℓ) and short wavelength (subscript s). The short half was scanned first (in time). The adjusted calibration equations for wavelength for each half are given by

$$\lambda_\ell = (2.388\ \mathrm{E}{-1})\ P_n - 1.097\ \mu\mathrm{m} \qquad (3\text{-}1)$$

$$55 \le P_n \le 97\%$$

$$\lambda_s = (7.38\ \mathrm{E}{-2})\ P_n + 3.333\ \mu\mathrm{m} \qquad (3\text{-}2)$$

$$4.0 \le P_n \le 44.4\%$$

where P_n is the percentage into the scan ($P_n = 100\ n/N$).

The wavelength resolution elements at any wavelength determined by the CVF filter are given for each filter half by,

$$\Delta\lambda_s = (1.8667\ \mathrm{E}{-2})\ \lambda + 6.21\mathrm{E}{-2}\ \mu\mathrm{m} \qquad (3\text{-}3)$$

$$\Delta\lambda_\ell = (5.482\ \mathrm{E}{-3})\ \lambda + 3.12\mathrm{E}{-1}\ \mu\mathrm{m}$$

3.1.2 Radiance Calibration

During actual radiance (brightness) calibration of the HS-3B-1 CVF the sensor output was a continuous analog signal and demodulation and rectification of the signal was accomplished using a phase sensitive amplifier (PAR). Since the telemetry signal was PCM this technique was not possible so a computerized demodulation and rectification scheme had to be formulated to accomplish these tasks which included the laboratory calibration data. This formulation is derived in section 3.3.1 of this report. However, the final result to convert demodulated rectified telemetry volts V_{TM} to spectral radiance is given here

$$B_n = G_i \; M_{(col)} V_{TM}/\Delta\lambda \quad MR/\mu m \tag{3-4}$$

where B_n = brightness (radiance) of data point n

G_i = channel gain (high gain = 1, low gain = 100)

$M_{(col)}$ = calibration factor in MR/volt (see Table 2.1-1)

$\Delta\lambda$ = resolution (see equation (3-3))

The adjusted laboratory calibration data for $M_{(col)}$ is given in Table 3.1-1 in units of MR/volt. Notice that the values are zero at 17.50 and 17.70 µm where the long wavelength filter point occurs. Other values in the original data near the mask regions are located have also been adjusted to eliminate the tendency to "spike" when the mask passes over the sensor. A plot of the final calibration is shown in Figure 3.1-1 in units of MR/µm - volt and derived using the data in Table 3.1-1 and equation (3-3).

3.2 Telemetry Signal

All aspects of the HS-3B-1 PCM telemetry were identical with CVF NS-6-4 (see section 2.2 of this report) except that since the HS-3B-1 CVF was optically chopped one additional channel of data was required (compared to the NS CVF) for the chopping frequency. The spectral data was contained in PCM words 5 + 29 (low gain) and words 6 + 30 (high gain). The spectral reference (start pulse) was on words 7 + 31 and the chopper sequel on word 46. Spectral scan start times are determined in the same manner as the NS instrument, see Appendix B for the listing of HS-3B-1 start times.

TABLE 3.1-1

$M(col)_N$ vs. Wavelength HS 3B-1

λ µm	$M(col)_N$ MR/volt	λ µm	$M(col)_N$ MR/volt	λ µm	$M(col)_N$ MR/volt
Short Wavelength Half		Long Wavelength Half			
3.70	0	11.90	0	18.50	.8375
3.80	0	12.10	0	18.70	.8225
3.90	7.91	12.30	0	18.90	.821
4.00	4.54	12.50	0	19.10	.843
4.10	4.335	12.70	1.53	19.30	.869
4.20	4.20	12.90	1.26	19.50	.8825
4.30	4.155	13.10	1.16	19.70	.902
4.40	3.885	13.30	1.15	19.90	.9235
4.50	3.61	13.50	1.09	20.10	.8985
4.60	3.41	13.70	1.05	20.30	.875
4.70	3.255	13.90	1.025	20.50	.8935
4.80	3.14	14.10	.9635	20.70	.920
4.90	3.08	14.30	.8545	20.90	.9405
5.00	2.97	14.50	.836	21.10	.951
5.10	2.85	14.70	.8855	21.30	.964
5.20	2.75	14.90	.8905	21.50	.9805
5.30	2.70	15.10	.835	21.70	.9805
5.40	2.625	15.30	.7925	21.90	.9805
5.50	2.57	15.50	.7665	22.10	.9805
5.60	2.50	15.70	.763	22.30	.9805
5.70	2.50	15.90	.804	22.50	0
5.80	2.51	16.10	.853	22.70	0
5.90	2.49	16.30	.8765	22.90	0
6.00	2.475	16.50	.8205		
6.10	2.42	16.70	.716		
6.20	2.33	16.90	.735		
6.30	2.265	17.10	.7545		
6.40	2.285	17.30	.8725		
6.50	2.30	17.50	0		
6.60	2.215	17.70	0		
6.70	2.14	17.90	.9005		
6.80	2.125	18.10	.813		
6.90	0	18.30	.8765		

3.3 Data Processing

The idea of chopped systems accompanied by phase sensitive demodulation and detection to reduce DC drift and improve signal to noise is well known (Schwartz, 1959) and widely used by electronic engineers. However for actual digital CVF data such as that of NS-3B-1 some special problems occur and so a brief review of the fundamentals will be presented prior to describing the actual data reduction techniques used for CVF HS-3B-1.

Figure 3.3-1 illustrates how the HS-3B-1 CVF modulated signal was produced. Since the CVF selectively passes the incident spectral radiance as it rotates at a constant rate the incident spectral radiance can be represented as a function of time instead of wavelength. This is shown in the top plate of Figure 3.3-1. The incident spectral radiance is periodically interupted by a mechanical chopper which itself radiates some lower level since it is cooled. The chopped signal as seen by the CVF sensor is shown in the second plate of Figure 3.3-1. The sensor output is assumed proportional to this incident radiance. If we assume for the moment that the chopper radiance is negligible and that the frequency bandwidth of the incident spectral radiance is small compared to the chopper frequency then the sensor output can be estimated by the Fourier series

$$s(t) = \frac{1}{2} S_{(\lambda)} \left[1 + 2 \sum_{n=1}^{\infty} \frac{\sin n\pi/2}{n\ \pi/2} \cos n\omega_c t \right] \qquad (3\text{-}5)$$

where $s(t)$ = chopped spectra signal

$S_{(\lambda)}$ = infrared spectra (unchopped)

ω_c = radian chopping frequency

If we now assume that there is no incident spectral signal and the chopper radiance is not negligible then the signal output from the chopper radiance alone can be written in a similar manner except that there will be a 180° phase difference

$$b_{(t)} = \frac{1}{2} R_{(\lambda)} \left[1 + 2 \sum_{n=1}^{\infty} \frac{\sin n \pi/2}{n \pi/2} \cos (n\omega_c t + \pi)\right]$$

where $b_{(t)}$ = chopped chopper signal

$R_{(\lambda)}$ = chopper unchopped radiance

ω_c = radian chopper frequency

Clearly the phase angle π can be omitted simply by changing the + sign in front of the summation to -.

For the case of both incident spectral radiance and non zero chopper radiance the total sensor output signal is the sum of s(t) and $b_{(t)}$

$$g(t)=s(t)+b_{(t)}=\frac{1}{2}(S_{(\lambda)}+R_{(\lambda)})+(S_{(\lambda)}-R_{(\lambda)}) \left[\sum_{n=1}^{\infty} \frac{\sin n\pi/2}{n \pi/2} \cos n\omega_c t\right] \quad (3\text{-}6)$$

If we now A.C. Couple this output signal to remove the DC term $\frac{1}{2}(S_{(\lambda)} + R_{(\lambda)})$ then filter with a narrow bandpass filter centered at the fundamental chopping frequency ω_c we get for n=1

$$g(t) = \frac{2}{\pi} (S_{(\lambda)} - R_{(\lambda)}) \cos \omega_c t \quad (3\text{-}7)$$

This result is the modulated waveform of the EXCEDE sensor output shown in plate 3 of Figure 3.3-1. This sensor output was digitized on the payload and telemetered and recorded in PCM format. Actual data is shown in Figure 3.3-1A.

The sinusoidal waveform of the chopper reference (also digitized and telemetered) in plate 4 of Figure 3.3-1 is simply expressed as

$$h(t) = A \cos (\omega_c t + \Delta\theta) \quad (3\text{-}8)$$

where h(t) = A.C. Component of the chopper signal.

$\Delta\theta$ = phase difference between data and chopper signals.

A = amplitude of the chopper signal.

The phase difference $\Delta\theta$ is included in this equation to account for such things as mechanical lag in sensing chopper position which would produce a phase difference between the sensor signal and the chopper reference.

In principle the demodulation and extraction of the spectra $S_{(\lambda)}$ from equation (3-7) is done by forming the product of h(t) and g(t), which expanded and simplified yields

$$\begin{aligned} P = g(t)h(t) &= \frac{2A\,(S_{(\lambda)}-R_{(\lambda)})}{\pi} \cos \omega_c t \cos(\omega_c t + \Delta\theta) \\ &= \frac{A\,(S_{(\lambda)}-R_{(\lambda)})}{\pi} \left[\cos\Delta\theta + \cos(2\omega_c t + \Delta\theta)\right] . \end{aligned} \tag{3-9}$$

We now filter the product P with a low pass filter with cutoff frequency less than $2\omega_c$ and greater than the highest data frequency in the spectral radiance. Solving for $S_{(\lambda)}$ yields

$$S_{(\lambda)} = R_{(\lambda)} + \frac{\pi P'}{A \cos \Delta\theta} \tag{3-10}$$

where P' represents the low pass filtered product of h(t) and g(t).

Equation (3-10) shows that the chopper radiance background is added to the incident signal and clarifies why it is necessary to keep the chopper radiance small (cold). Also if either the chopper amplitude A or the phase angle difference $\Delta\theta$ between spectral data and chopper reference are modulated with time in any manner false components will be introduced into the reduced spectra.

Notice from Equation (3-7) that if the incoming radiation $S_{(\lambda)}$ is less than the chopper radiation $R_{(\lambda)}$ then g(t) is negative and the product term in Equation (3-10) will also be negative resulting in a quantity of radiation being subtracted from $R_{(\lambda)}$ to give $S_{(\lambda)}$ just as it should be. If one attempted to retrieve the spectra $S_{(\lambda)}$ by simply reconstructing the envelope of g(t) this possibility would not be detected and an error in $S_{(\lambda)}$ would result. On the other hand multiplying by chopper signal and filtering as explained, preserves all the phase properties of the signal. It is crucial however, to derive an accurate representation of the chopper data characteristics.

3.3.1 Data Reduction

Several problems arise in attempting to apply the principles derived above to the EXCEDE chopped CVF PCM data. For one thing all the data channels were sampled (on the payload) serially so that the chopper reference data points were not time coincident with the spectral data points. In addition the chopper was sampled at 512 Hz - just half the spectral data sample rate. Thus forming the correct product P (Equation (3-9)) of the chopper and spectral data needed for demodulation was not possible. Consequently it was elected to fit the digital chopper data for each spectral scan with a least squares technique to derive an analog equation to be used in forming the product term in Equation (3-3). The mean value of the chopper reference signal data was found and subtracted from the data set. An estimated frequency (f_c) of the signal was found by counting zero crossings during each scan and dividing by two times the product of the total number of data points and the sampling interval, viz.

$$f_c = \frac{N_0}{2N_{TOT}\Delta t} = \frac{N_0 f_s}{2N_{TOT}} \qquad (3\text{-}11)$$

where f_c = chopper frequency - Hz

N_0 = number of zero crossing in the scan

N_{TOT} = total number of data points in the scan (1/2 number spectral data samples)

Δt = sampling interval

$f_s = 1/\Delta t$ = sampling frequency = 512 Hz.

Since the total number of chopper data points N_{TOT} is known precisely (1/2 the number of spectral data points) for each scan and the sampling frequency is considered invariant the error Δf_c in determining f_c is at most due to the error of missing one zero crossing and thus

$$\Delta f_c = \frac{(1)512}{2(616)} = 0.42 \text{ Hz}$$

(The value 616 for N_{TOT} was estimated based on 1232 data points in a typical spectral data scan - see Appendix A).

Knowing the frequency the assumed chopper sinusoidal signal equation derived below was least squares fitted to the data in each spectral scan.

$$h(t) = A\cos(\omega_c t - \theta_c) = A\cos\omega_c t \cos\theta_c + A \sin\omega_c t \sin\theta_c \qquad (3\text{-}12)$$

$$h(t) = b \cos \omega_c t + c \sin \omega_c t$$

where $h(t)$ = chopper signal

A = amplitude

θ_c = phase angle relative to the scan start

$b = A \cos \theta_c$

$c = A \sin \theta_c$

As a result of the fit the constants b and c are found and the phase angle is determined by (see Figure 3.3-2 for typical data fit)

$$\theta_c = +\tan^{-1} \left(\frac{c}{b}\right) \qquad (3\text{-}13)$$

Finally setting the amplitude A=1 the chopper signal equation in digital form is

$$h_{(n)} = \cos\,[2\pi f_c (n-1)\Delta t - \theta_c] \tag{3-14}$$

$$n = 1,2,3,\ldots\ldots N_{TOT}$$

where h(n) = chopper equation

f_c = chopper frequency - Hz

n = data point number

Δt = sample interval = $\frac{1}{1024}$ sec. for the spectral data

θ_c = phase angle relative to the scan start

N_{TOT} = total data points in the scan.

In actual practice the frequency f_c was computed by the fit. Appendix C contains a tabulation of the phase angle and f_c θ for the actual data derived as discussed above for each spectral scan. Included in this tabulation is the "goodness of fit" parameter chi squared. The lower the number the better the fit. A typical example of the calculated chopper reference (solid line) using Equation (3-14) compared to the actual chopper data (points) is shown in Figure 3.3-2. As long as the chopper reference data amplitude was relatively constant (which was not always the case) the fit with Equation (3-14) was excellent.

Clearly Equation (3-14) permits calculating the necessary value of the chopper reference for any spectral data point n and thus satisfies the requirements needed for evaluating the product P in Equation (3-9) (which implied $\theta_s=0$). When there is a phase difference between the spectral data and the chopper defined by $\theta_c-\theta_s = \Delta\theta$ where θ_s and θ_c are the phase differences from the start of scan for spectra and chopper respectively, Equation (3-7) becomes

$$g(t) = \frac{2}{\pi}(S_{(\lambda)}-R_{(\lambda)})\ \cos(\omega_c t-\theta_s)$$

It was found by inspection of the data that the chopper lagged the spectral data by 1/3 a spectral data point (12°) so that $\Delta\theta = -12°$.

An example of the product P for scan 1211 formed by multiplying each spectral data point in the scan by a numerical value computed for the chopper using Equation 3-14 for the same n (constant A=1 and the appropriate phase angle θ_c taken from Appendix C) is shown in Figure 3.3-3, both the high and low gain channels are shown. The product was evaluated in telemetry units of counts for the spectral data g(t) while h(t) is dimensionless. Prior to forming the product the mean of the modulated spectral data was determined and subtracted from each data value of g(t). Theoretically the mean of the modulated wave should be zero. Note that all prominent count values, in Figure 3.3-3, are positive except for a few spurious data points in the high gain channel where the signal was saturated. In addition the noise values oscillate about zero as it should. The envelope of the data in Figure 3.3-3 contains the desired spectral information. All that is required to derive the spectrum is to extract the envelope and apply calibrations for wavelength and brightness. Ripple on the high gain is explained later.

Typically envelope detection is done by smoothing or filtering. Clearly the only useful data points of the waveforms shown in Figure 3.3-3 are the peak values since only they represent the observed spectrum. Since filtering of digital data is a somewhat complicated process especially with large data bases and when Fourier transforms are involved it was decided to attempt to derive the envelope data by a decimation technique prior to filtering.

Using the concept of referring phase angles of both the chopper reference and spectral data to the beginning of the scan and acknowledging that these phase angles could be different the product term of Equation (3-9) can be rewritten as

$$P = \frac{A}{\pi}(S_{(\lambda)} - R_{(\lambda)}) \left\{ \cos(\theta_s - \theta_c) + \cos[2\omega_c t - (\theta_c + \theta_s)] \right\} \qquad (3\text{-}15)$$

since $\theta_c - \theta_s = \Delta\theta$ is constant the maximum value of the product P occurs when the $\cos[2\omega_c t - (\theta_c + \theta_s)] = +1$. Thus the data point number n_p defining the maximum value is

$$2[2\pi(n_p - 1)\ f_c \Delta t] - (\theta_c + \theta_s) = 2(i-1)\ \pi$$

$$i = 1, 2, 3, \ldots\ N_{TOT}\ .$$

Therefore solving for n_p yields

$$n_p = 1 + \frac{(i-1)\ \pi + (\theta_c + \theta_s)/2}{2\pi f_c \Delta t}\ . \qquad (3\text{-}16)$$

Since θ_c is arbitrary it is clear that values of n_p computed with Equation (3-16) could take on non-integer values which do not exist in the digital data base, viz. data points are numbered in integer steps from 1 at scan start to N_{TOT} at the end of the scan. Assuming the sampling rate f_s is invariant (1024 samples/sec) and equal to the reciprocal of the sample interval time Δt Equation (3-1) is rewritten as follows

$$n_o = \text{round off integer value} \left[1 + \frac{(i-1)\ \pi + (\theta_c + \theta_s)/2}{2\pi f_c / f_s} \right] \qquad (3\text{-}17)$$

$$i = 1, 2, 3, \ldots N_{TOT}\ .$$

The envelope data base was determined for each scan by choosing only data points defined with Equation (3-17). The data point difference $\Delta n_o = 5$ and thus the data base was reduced by a factor of 5 by this decimation process and contained only the estimated envelope data.

Once the envelope data base was generated in this manner the spectral data in counts was converted to volts using the relationship

$$V_{TM} = \frac{C}{100} = \frac{P}{100} \qquad (3\text{-}18)$$

where V_{TM} = telemetry volts

C = counts

This equation differs slightly from that used for the NS instrument (Equation (2-8)) because the A.C. coupling of the HS sensor output removes the 12 count D.C. offset. The decimated envelope data base derived by Equation (3-16) was units of counts. These data were converted to volts simply by dividing by 100 in accordance with Equation (3-18).

Returning to the basic relationship for deriving the product p in Equation (3-15), we must recall in subsequent discussion that we have already assumed the amplitude A of the chopper reference signal to be constant and equal to 1 and also that the phase difference $\Delta\theta$ between chopper reference and spectral data to be +12°. Finally we make the assumption that chopper radiance $R_{(\lambda)}$ is negligible compared to the spectrum since it is cooled. In addition we have used n_o in choosing the envelope instead of n_p so solving for the spectrum $S_{(\lambda)}$ yields

$$S_{(\lambda)} = \frac{\pi P}{\cos\Delta\theta + \cos 2[2\pi f_c(n_o-1)\Delta t - (\theta_c-\theta_s)/2]} \tag{3-19}$$

The units of $S_{(\lambda)}$ are counts. Notice the denominator ≈2 for small $\Delta\theta$. It was decided to first generate a data base where the spectra was not filtered but in the correct units of MR/µm then filter the data set in units of radiance. This precaution was taken in the event the voltage calibration was not linear. The unfiltered spectral radiance was thus calculated from the unfiltered decimated data base where $V_{TM} = \frac{S_{(\lambda)}}{100}$

$$B_{(\lambda)} = G_i\, M_{(col)}\, V_{TM}/\Delta\lambda \tag{3-20}$$

where $B_{(\lambda)}$ = unfiltered spectral radiance MR/µm

P = decimated product term (unfiltered) in units of

$M_{(col)}$ = calibration term - MR/volt

$\Delta\lambda$ = calibration term - µm (see Equation (3-3))

V_{TM} = decimated spectra term expressed in volts

G_i = gain factor (high gain = 1, low gain = 100)

Equation (3-21) was given previously in Equation (3-4) of this report.

Figure 3.3-4 shows a sample unfiltered spectral radiance profile derived by the techniques described above. The ripple on the spectra is caused by a chopping feed-through effect (viz cos $2\omega_c t$ term in Equation (3-9)) which was intentionally not filtered before initial examination of the spectral data. The spectral data shows the emission features of CO_2 at 4.28 and 14.97 μm and NO in the 5 to 6 μm region. However the need of filtering to remove the chopper effect is evident.

As a first approach a simple nonrecursive filter was used for initial data smoothing. The filtered brightness B_n' at point n is computed as follows

$$B_n' = [aB_{n-2} + bB_{n-1} + cB_n + bB_{n+1} + aB_{n+2}] \qquad (3\text{-}21)$$

The transfer function of this filter is (Hamming, 1979)

$$H_{(\omega)} = 2a \cos 2\omega + 2b \cos \omega + c \qquad (3\text{-}22)$$

where $\omega = \pi f/f_N$

f_N = 1/2 Δt = fs/2 Nyquist frequency

fs = sampling frequency after decimating = 205 Hz

f = physical frequency

For this case we desire good low pass characteristics, so using the conditions

$$H(0) = 1$$

$$\frac{dH(0)}{d\omega} = 0 \qquad (3\text{-}23)$$

$$\frac{d^2H(0)}{d\omega^2} = 0$$

leads to the following values

$$a = -1/16$$
$$b = +1/4$$
$$c = +5/8 \qquad (3\text{-}24)$$

A plot of the frequency response of this filter is shown in Figure 3.3-5.

The decimated data base was processed using Equation (3-21) to produce initial smoothed data. Spectral scan 1210 (Figure 3.3-6) illustrates the effect of the smoothing and the improvement of spectral radiance features are shown in Figure 3.3-6 as compared to Figure 3.3-4.

3.3.2 Data Base (HS-3B-1)

An "abridged" data base was generated for selected spectral scans from the HS-3B-1 CVF using the procedures outlined above. These data are given in Appendix E. In general the spectra show emission enhancement during periods of "gun" (accelerator) on times but in addition there seems to be a background enhancement (scan 1067) at times when the guns are off. This is attributed to the possibility of instrument covers floating through the CVF field of view. The fine structure in some of the enhanced emissions (see 5.8 μm of scan 1204) is due in part to the effects of chopper second harmonic and sampling which is explained in more detail in the next section of this report.

It should be noted that the spectral data shown in Appendix E consist of merged results from both the high and low gain channels. A signal voltage of 4.2 volts was used as the criterion for merging the two gain channels.

3.4 Discussion

The ripple (~40 Hz) supperimposed on the demodulated waveform in Figure 3.3-3 is clearly an error source since it falls within the digital filter passband (see Figure 3.3-5). Power spectral density analyses of these signals do not indicate the presence of the 40 Hz ripple, however, the chopper second harmonic (212 Hz) is evident in the PSDs of both the spectral and chopper data. This indicates that the chopper second harmonic is leaking into the signals due to poor frequency cutoff characteristics of the system electronic filter on-board the payload. Inspection of the electronic characteristic in Figure 3.4-1 confirms this possibility. A simple trigonometric exercise demonstrates the point. Assume the chopper fundamental waveform is added to the second harmonic waveform approximately 90° out of phase and with reduced amplitude "a".

$$h_{(t)} = \cos\omega_c t + a\sin(2\omega_c t - \varphi) \qquad (3\text{-}35)$$

where φ = small phase angle ~9°

$h_{(t)}$ = chopper waveform

f_c = chopper frequency 106 Hz

$\omega_c = 2\pi(n-1)\ f_c/f_s$

f_s = sampling frequency 512 Hz

n = data point number

a = amplitude <1

Setting a = 0.2 and evaluating Equation (3-35) for n=54 to 154 we produce the simulated chopper waveform in Figure 3.4-2 (scale factors have been introduced for ease of comparison). Comparing this to a portion of the actual waveform indicates obvious similarity. Note that the ripple frequency in the chopper is only ~20 Hz (rather than 40 Hz as it is in the data) because sampling of the chopper was only 512 Hz compared to 1024 Hz in the case of the spectral data. As pointed out the ripple cannot be removed from the data without more sophisticated filtering techniques which are beyond the scope of this preliminary work.

There is also an inherent error in the spectral data due to a one count uncertainty due to digitization. One count is equivalent to 10 millivolts by Equation 3-18. From Equation 3-20 the noise radiance for this voltage in high gain (G=1) is

$$B_{min} = 0.01\ M_{(col)}\ /\ \Delta\lambda \tag{3-36}$$

where $M_{(col)}\ /\ \Delta\lambda$ is the calibration factor in MR/volt (see Figure 3.1-1) and $\Delta\lambda$ is the resolution. From the figure the calibration factor depends on wavelength showing values of 2.23 MR/μm-volt at ~15 μm and 16.9 MR/μm-volt at ~5.3 μm. This produces a noise of

$$B_{noise} = 0.02\ \text{MR}/\mu\text{m at } 15\ \mu\text{m}$$

$$B_{noise} = 1.7\ \text{MR}/\mu\text{m at } 5.3\ \mu\text{m}$$

These values are well below the signal levels encountered (see Appendix E).

An additional error is introduced by the decimation process because of the necessity to round off the computed peak value data point number to the integer value. This causes a cyclical error every 5 data points of about 10%.

PART C

4.0 RECOMMENDATIONS

Data processing techniques of Circular Variable Filter Spectrometers have developed in the past 5 years to a point where spectral results can be accepted with good confidence. However, limitations in interpreting processed spectra are imposed by a variety of design parameters. For instance leakage due to imperfect out-of-band rejection of the CVF can contaminate low spectral signals. The best blocking possible with a CVF is probably four orders of magnitude. Non-constant CVF rotation can cause wavelength errors comparable with the spectral resolution of the CVF. In the case of the EXCEDE HS-3B-1 poor rejection properties of the electronic filter caused chopper second harmonic to contaminate the data.

Specifically we recommend that the EXCEDE data and techniques presented here be considered preliminary and reviewed for adequacy in terms of the physics involved. The helium instrument (HS-3B-1) data should be reprocessed by more sophisticated techniques to reduce as much as possible the effects of second harmonic contamination.

5.0 ACKNOWLEDGEMENTS

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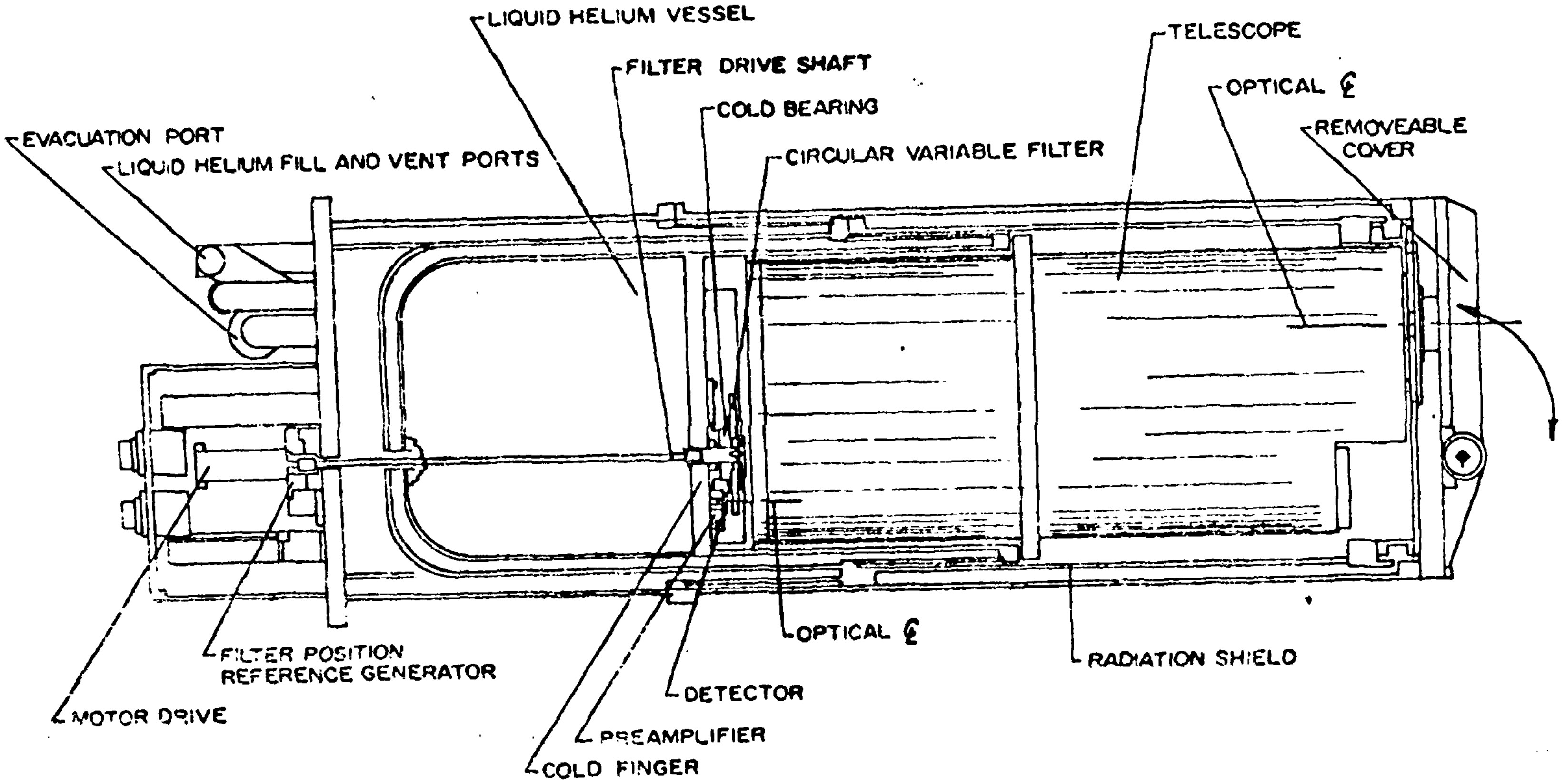
LIQUID HELIUM VESSEL
FILTER DRIVE SHAFT
COLD BEARING
CIRCULAR VARIABLE FILTER
TELESCOPE
OPTICAL ℄
REMOVEABLE COVER
EVACUATION PORT
LIQUID HELIUM FILL AND VENT PORTS
FILTER POSITION REFERENCE GENERATOR
MOTOR DRIVE
OPTICAL ℄
RADIATION SHIELD
DETECTOR
PREAMPLIFIER
COLD FINGER

Figure: 2.0-1 Schematic of a typical circular variable filter (CVF) spectrometer.

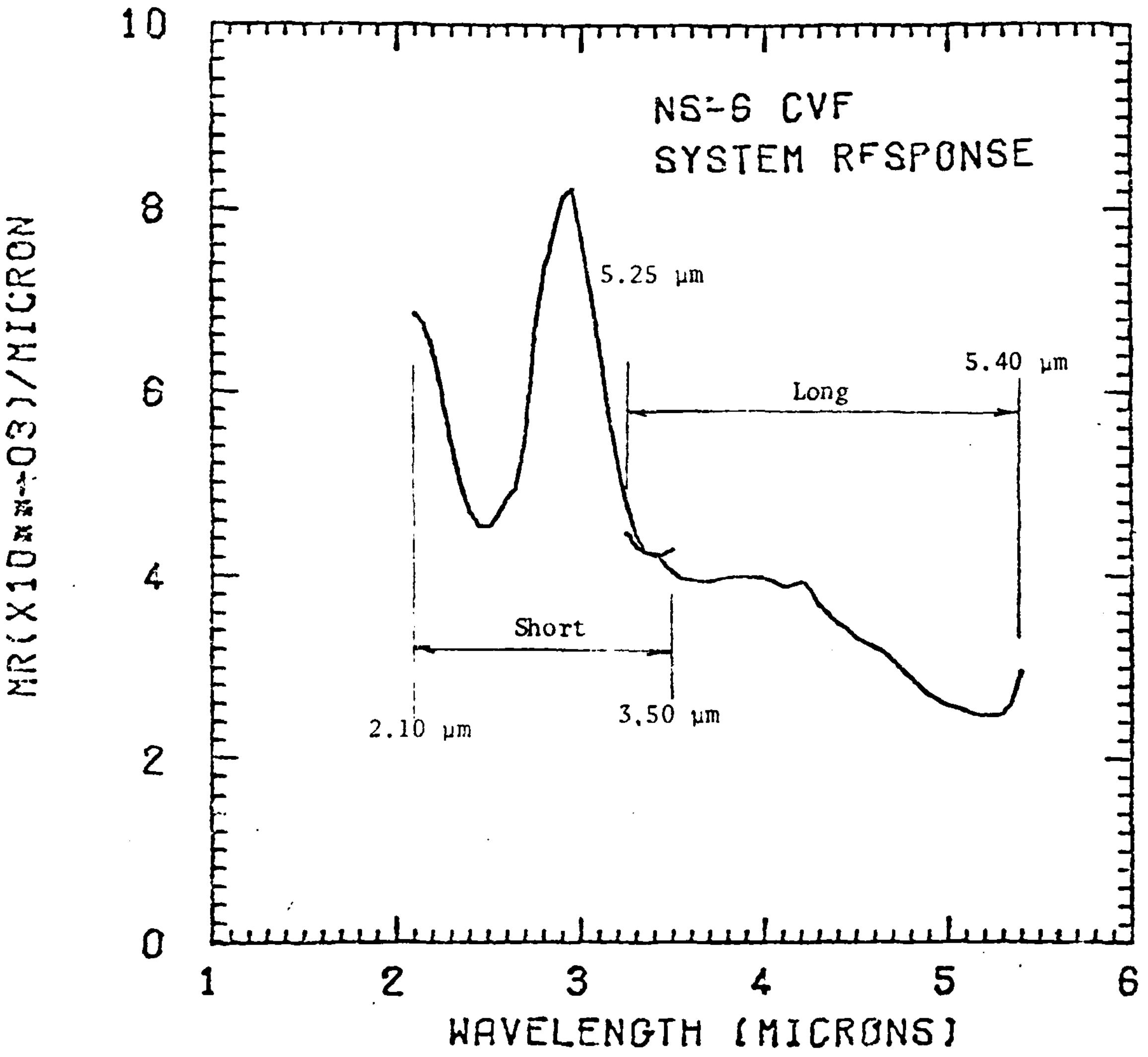

Figure 2.1-1. CVF brightness calibration (NS-6-4)

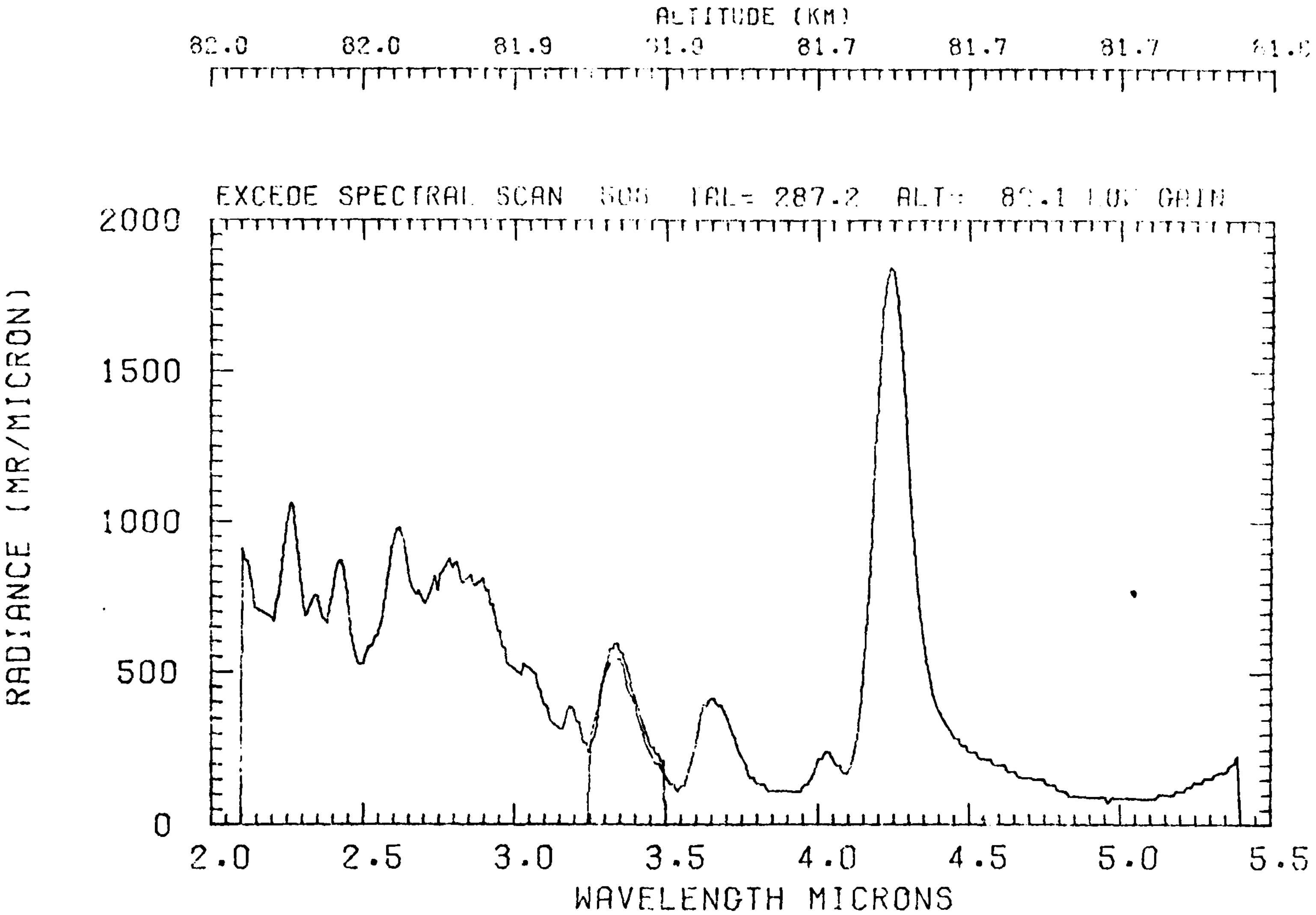

Figure 2.3-1. Sample spectra from EXCEDE short wavelength CVF spectrometer during electron gun operation.

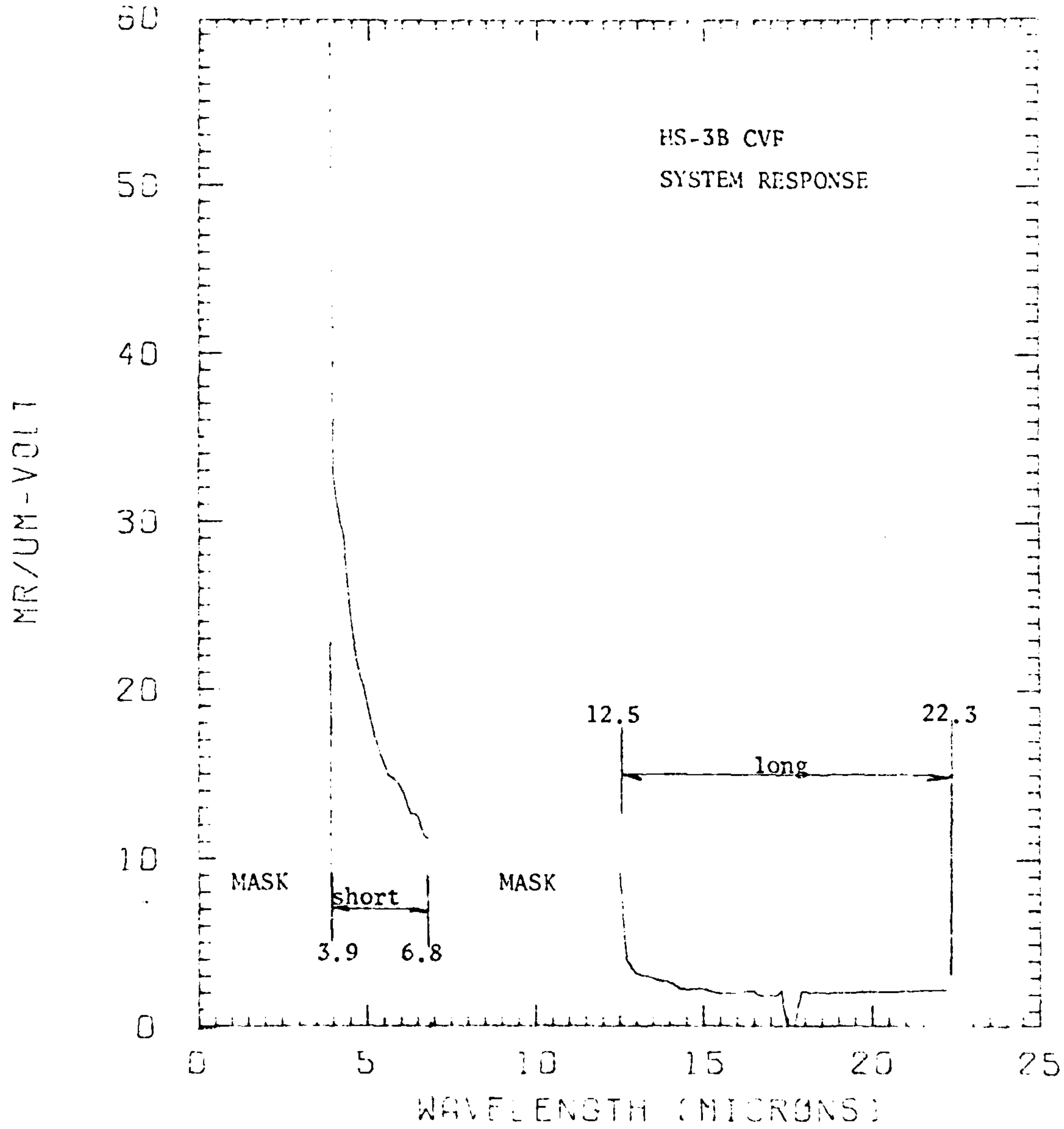

Figure 3.1-1 CVF Brightness Calibration (HS-3B-1)

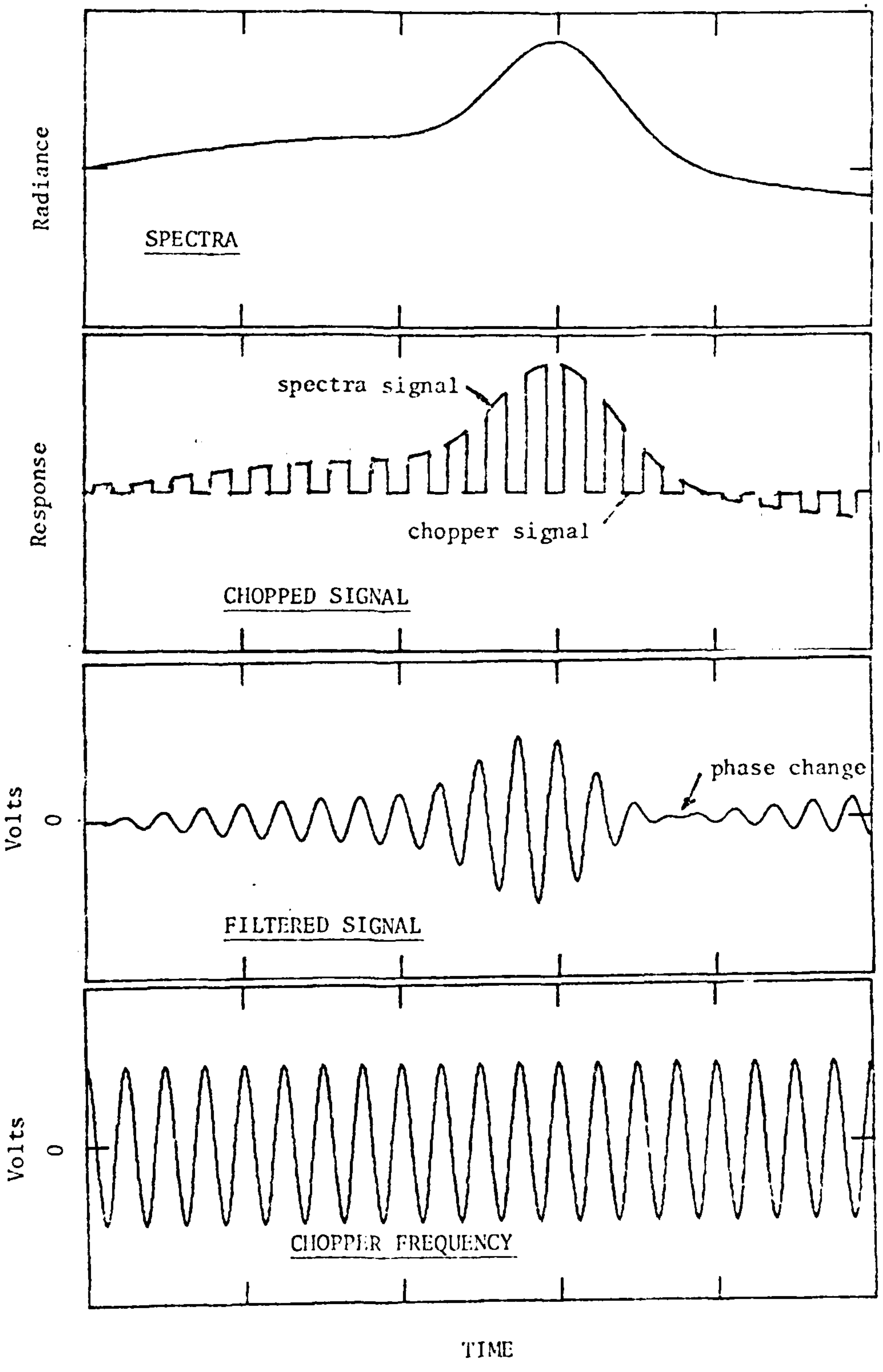
Radiance
SPECTRA
Response
spectra signal
chopper signal
CHOPPED SIGNAL
Volts
0
phase change
FILTERED SIGNAL
Volts
0
CHOPPER FREQUENCY
TIME

Figure 3.3-1. Principle of optically chopped CVF observation showing phase reversal when source radiance is less than copper radiance.

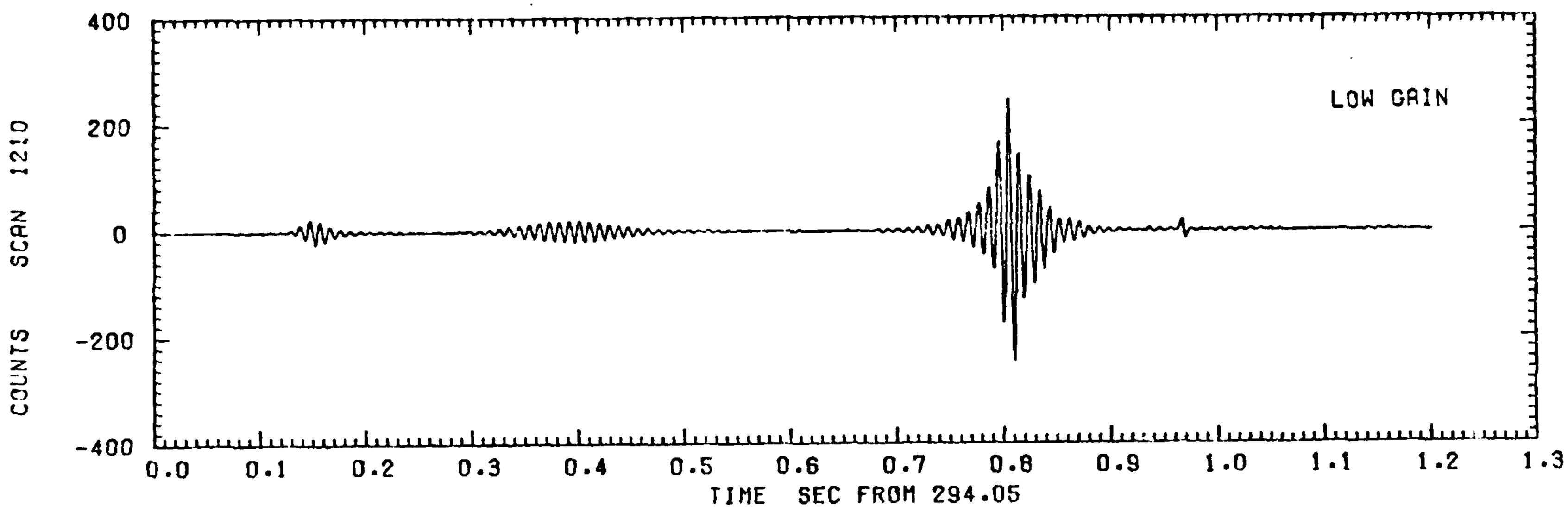

Figure 3.3-1a. A portion of telemetered data from the EXCEDE HS-3B-1 CVF spectrometer

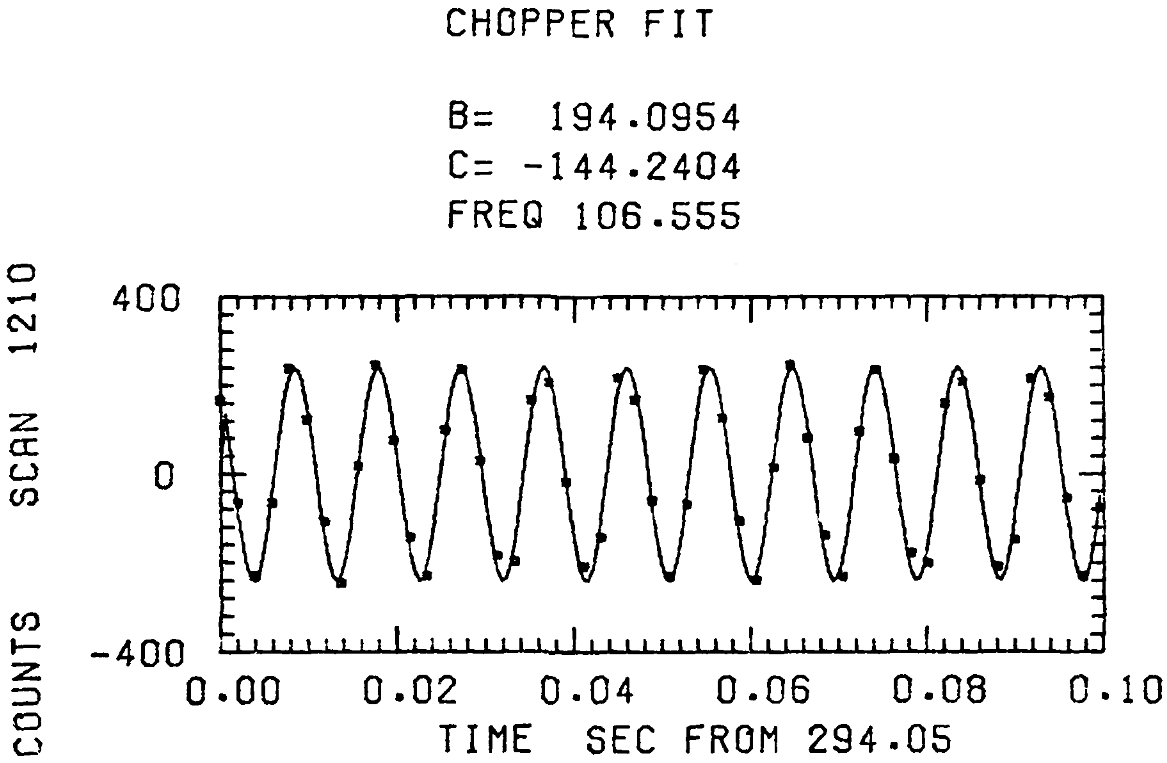

Figure 3.3-2. Example of least squares fit (sinusoid) to chopper signal (solid squares) for spectral scan 1210. Also shown are frequency and constants determined as a result of the best fit.

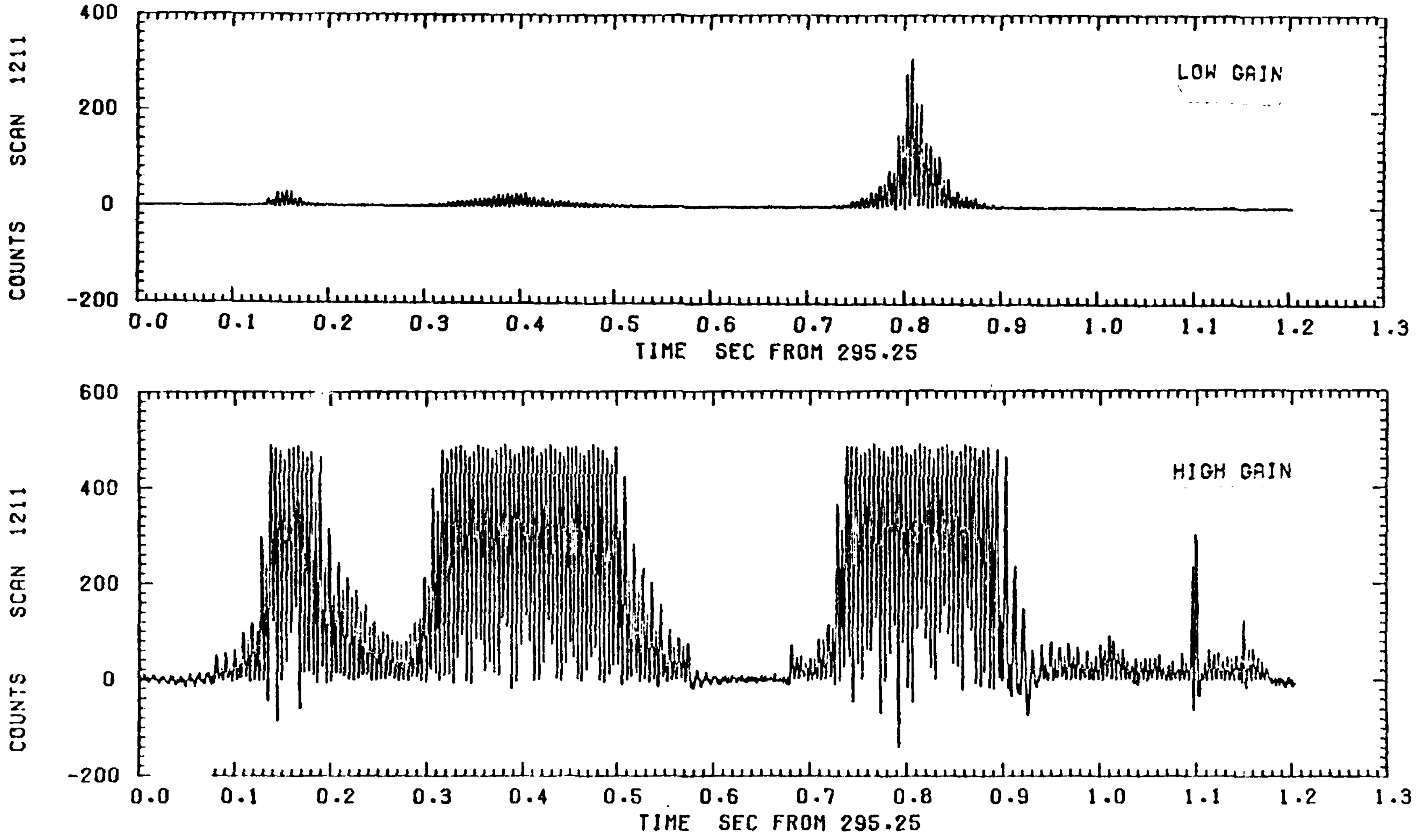
COUNTS SCAN 1211
400
200
0
-200
LOW GAIN
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
TIME SEC FROM 295.25
COUNTS SCAN 1211
600
400
200
0
-200
HIGH GAIN
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
TIME SEC FROM 295.25

Figure 3.3-3

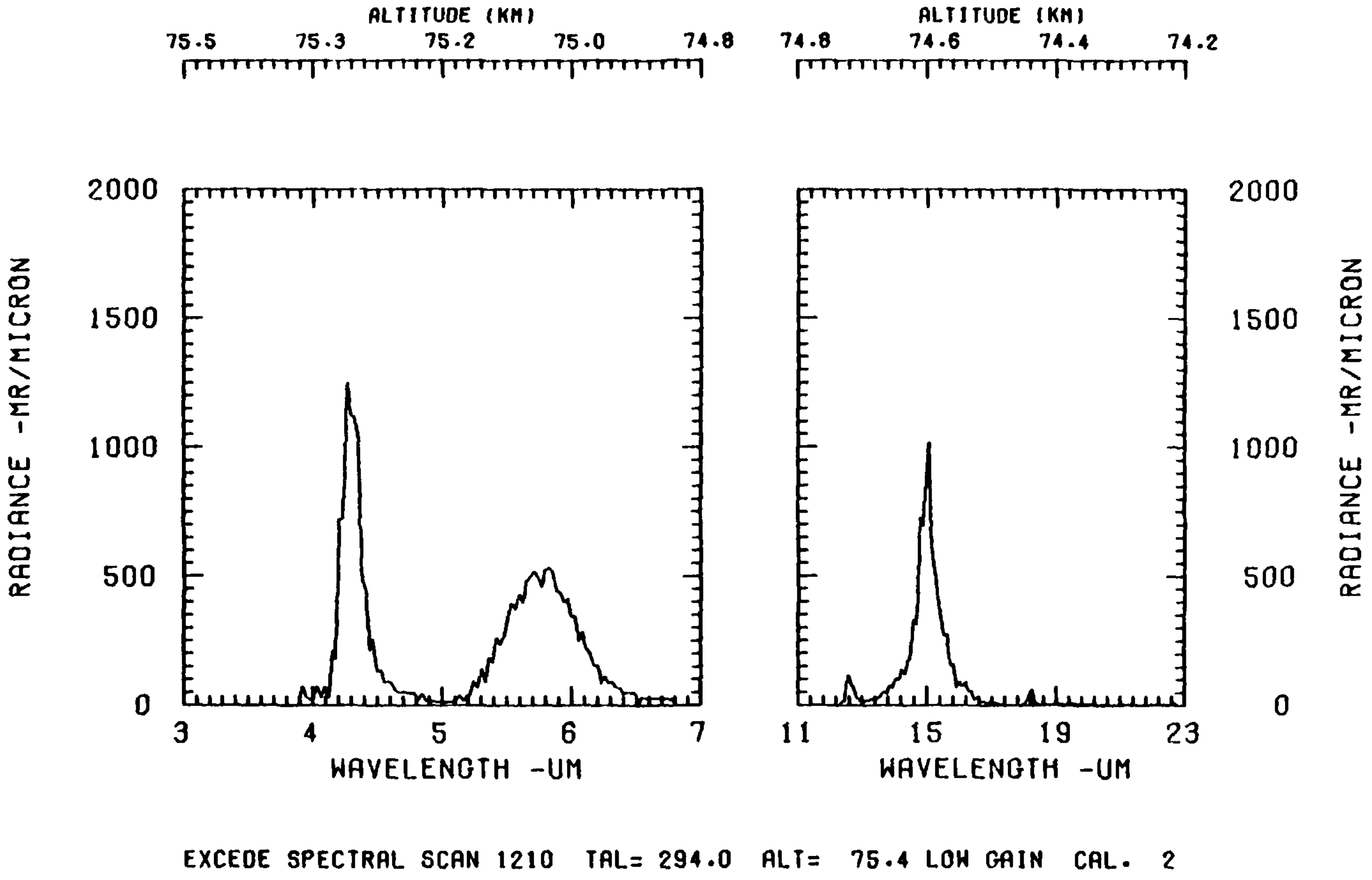

Figure 3.3-4 Example of unfiltered spectrum obtained with the EXCEDE chopped CVF.

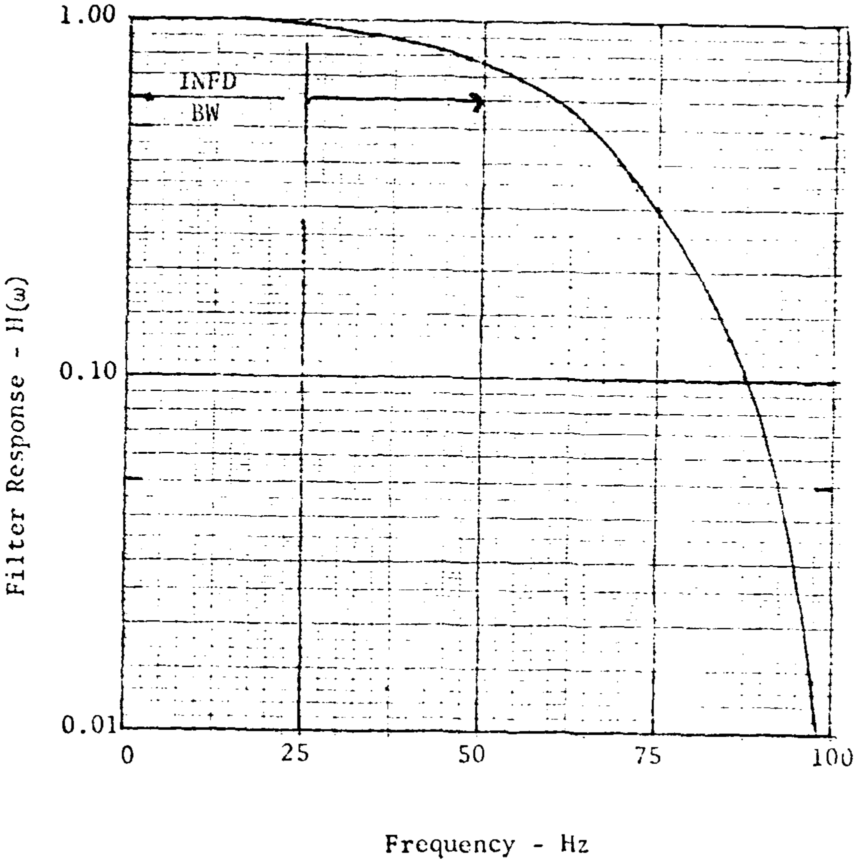

Figure 3.3-5. Frequency response of smoothing filter used after decimating data base to a sampling frequency of 205 Hz EXCEDE information bandwidth is 50 Hz.

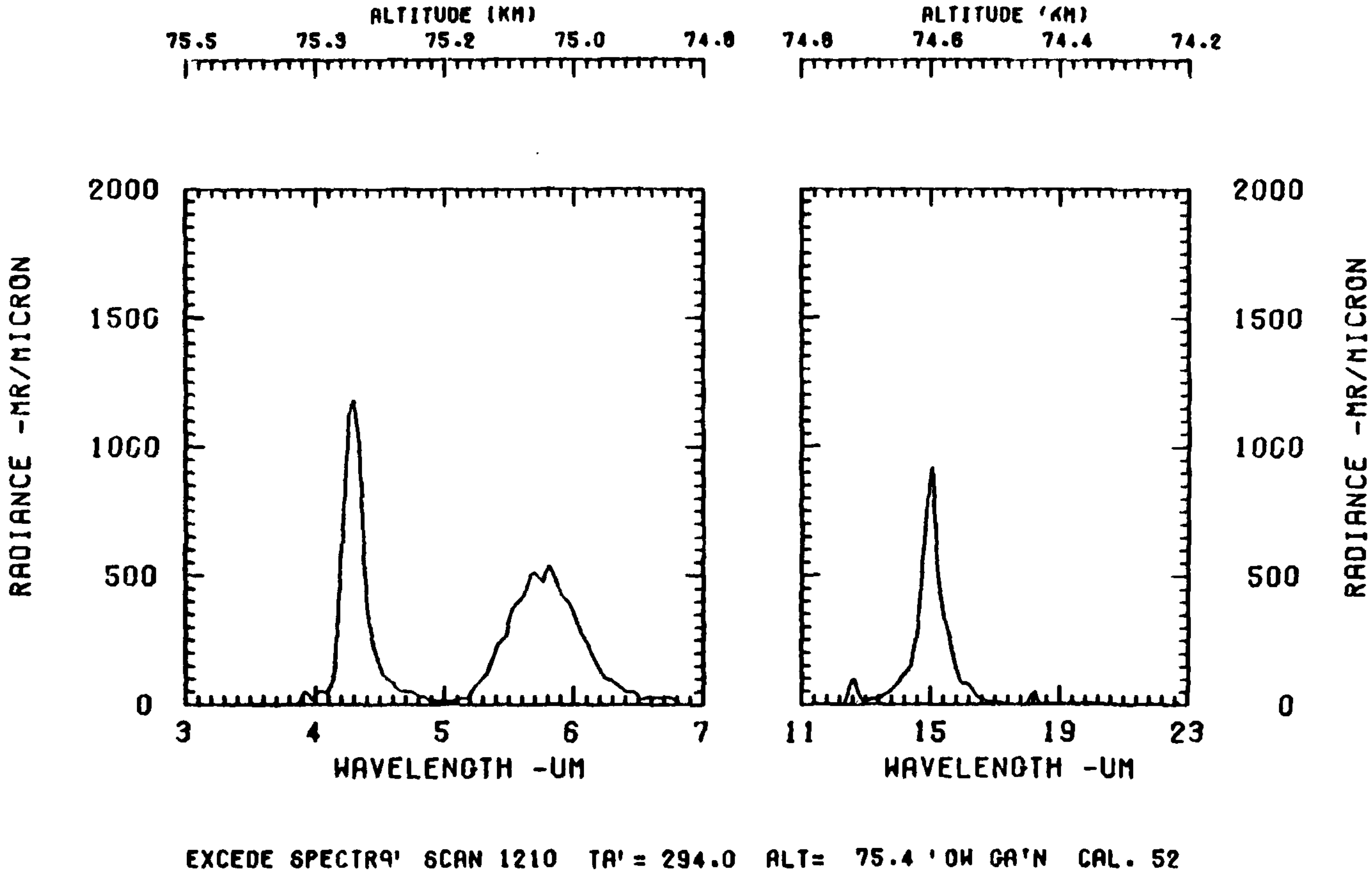

Figure 3.3-6 Example of smoothed spectrum using a 5 point smoothing filter.

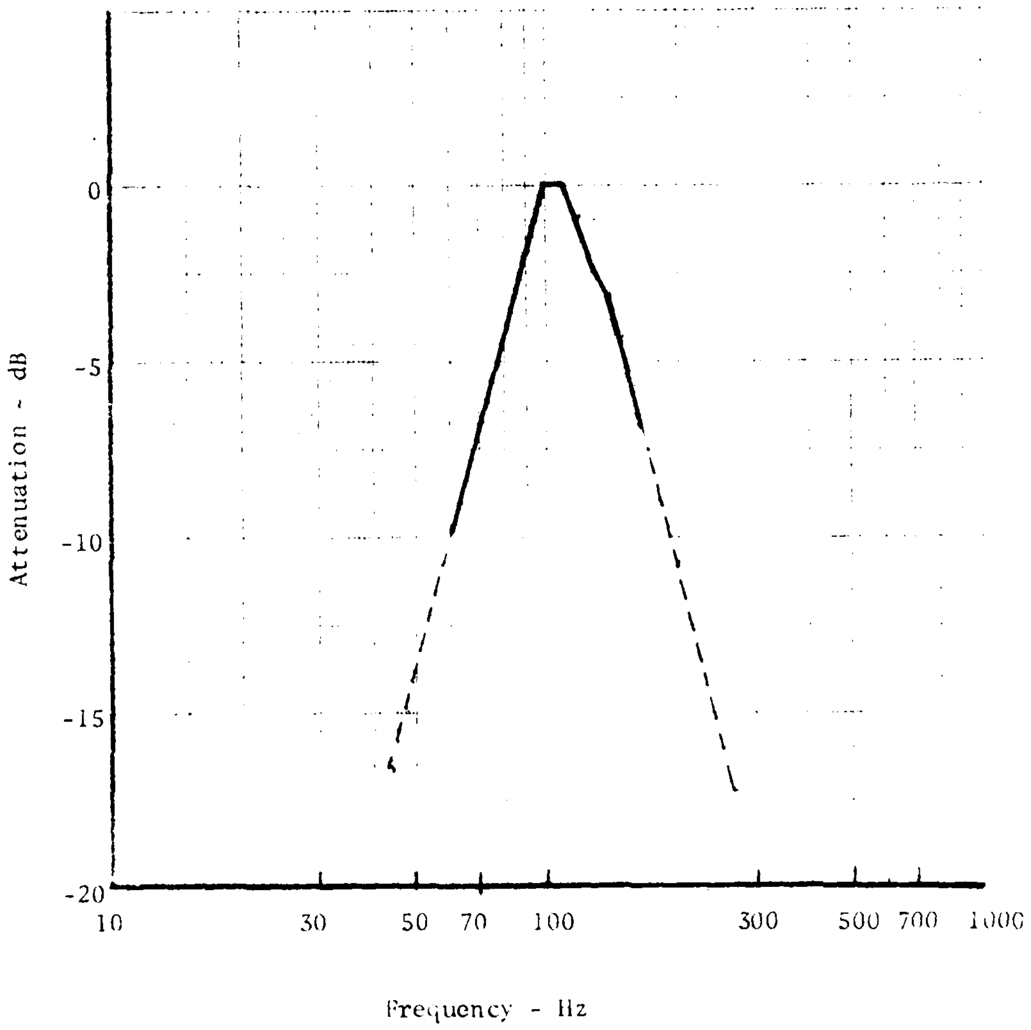

Figure 3.4-1 Characteristics of the electronic filter for CVF HS-3B-1

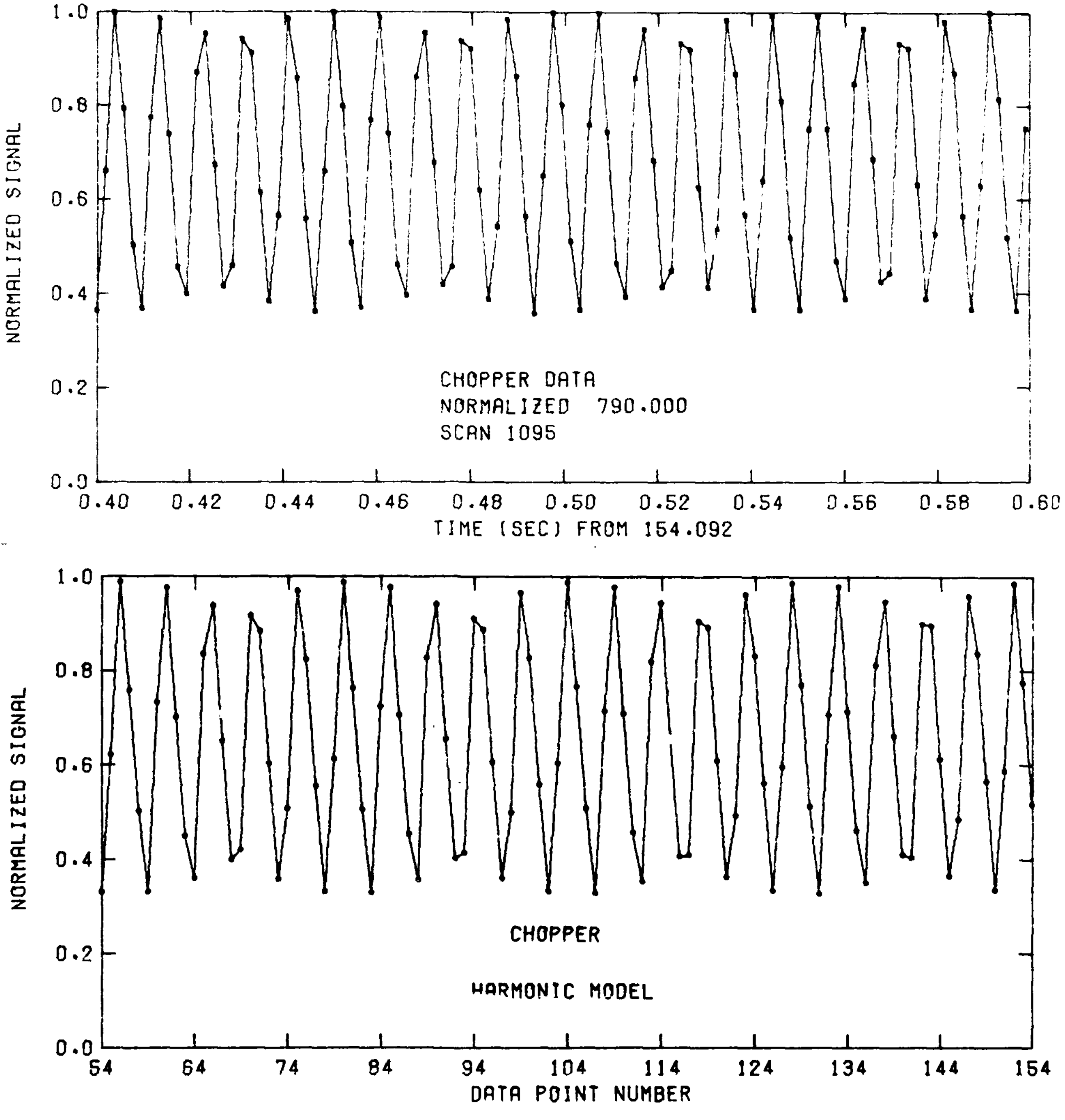

Figure 3.4-2. Comparison of chopper data with model of the form $S = K_1 + K_2 [\cos\omega_c t + a\sin(2\omega_c t - \phi)]$ where K_1 and K_2 are scale factors, and $\omega_c t = 2\pi f_c (n-1) f_s$, and $\phi = 9°$.

APPENDIX A

Spectral Scan Start Times and Other Data for NS-6-4 CVF

Data in this appendix is defined as follows:

Column	Title	Definition
1	Scan Number	Number assigned to the spectral scan
2	Length	Number of data points in spectral scan
3	Length sec	Duration of the spectral scan in seconds
4	Time A-L	Time after launch in seconds of scan start
5	Altitude	Payload altitude corresponding to T.A.L.
6	Time U.T.	T.A.L. in U.T. seconds
7	Clock Time U.T.	T.A.L. in clock form

```
EXCEDE II  NS-6  SPECTRAL SWEEP STARTS                                        05/02/80  13.37.41.          PAGE    1
     SPECTRAL S       LENGTH   LENGTH SEC      TIME AGL.      ALTITUDE      TIME U.T.     UT CLOCK TIME
        0001            492       .4820          40.2810       26.4254     20840.2810     5:47: 20.2810
        0002            496       .4860          40.7630       27.0912     20840.7630     5:47: 20.7630
        0003            493       .4810          41.2490       27.7618     20841.2490     5:47: 21.2490
        0004            496       .4840          41.7300       28.4225     20841.7300     5:47: 21.7300
        0005            494       .4840          42.2140       29.0882     20842.2140     5:47: 22.2140
        0006            494       .4830          42.6980       29.7437     20842.6980     5:47: 22.6980
        0007            492       .4820          43.1810       30.4007     20843.1810     5:47: 23.1810
        0008            494       .4840          43.6630       31.0551     20843.6630     5:47: 23.6630
        0009            495       .4850          44.1470       31.7100     20844.1470     5:47: 24.1470
        0010            492       .4820          44.6320       32.3630     20844.6320     5:47: 24.6320
        0011            494       .4840          45.1140       33.0098     20845.1140     5:47: 25.1140
        0012            496       .4850          45.5980       33.6552     20845.5980     5:47: 25.5980
        0013            494       .4840          46.0830       34.3016     20846.0830     5:47: 26.0830
        0014            496       .4840          46.5670       34.9465     20846.5670     5:47: 26.5670
        0015            496       .4850          47.0510       35.5882     20847.0510     5:47: 27.0510
        0016            494       .4840          47.5360       36.2270     20847.5360     5:47: 27.5360
        0017            494       .4840          48.0200       36.8633     20848.0200     5:47: 28.0200
        0018            494       .4830          48.5040       37.4974     20848.5040     5:47: 28.5040
        0019            493       .4820          48.9870       38.1280     20848.9870     5:47: 28.9870
        0020            498       .4880          49.4690       38.7551     20849.4690     5:47: 29.4690
        0021            498       .4870          49.9570       39.3818     20849.9570     5:47: 29.9570
        0022            496       .4840          50.4440       40.0170     20850.4440     5:47: 30.4440
        0023            494       .4840          50.9280       40.6491     20850.9280     5:47: 30.9280
        0024            494       .4830          51.4120       41.2610     20851.4120     5:47: 31.4120
        0025            502       .4920          51.8950       41.8784     20851.8950     5:47: 31.8950
        0026            496       .4850          52.3870       42.5051     20852.3870     5:47: 32.3870
        0027            494       .4840          52.8720       43.1225     20852.8720     5:47: 32.8720
        0028            494       .4840          53.3560       43.7326     20853.3560     5:47: 33.3560
        0029            494       .4830          53.8400       44.3424     20853.8400     5:47: 33.8400
        0030            492       .4820          54.3230       44.9488     20854.3230     5:47: 34.3230
        0031            502       .4920          54.8050       45.5517     20854.8050     5:47: 34.8050
        0032            495       .4845          55.2970       46.1643     20855.2970     5:47: 35.2970
        0033            495       .4845          55.7815       46.7666     20855.7815     5:47: 35.7815
        0034            494       .4830          56.2660       47.3560     20856.2660     5:47: 36.2660
        0035            498       .4880          56.7490       47.9514     20856.7490     5:47: 36.7490
        0036            494       .4840          57.2370       48.5607     20857.2370     5:47: 37.2370
        0037            496       .4850          57.7210       49.1529     20857.7210     5:47: 37.7210
        0038            498       .4880          58.2060       49.7441     20858.2060     5:47: 38.2060
        0039            504       .4930          58.6940       50.3367     20858.6940     5:47: 38.6940
        0040            504       .4940          59.1870       50.9372     20859.1870     5:47: 39.1870
        0041            494       .4830          59.6810       51.5295     20859.6810     5:47: 39.6810
        0042            498       .4880          60.1640       52.1086     20860.1640     5:47: 40.1640
        0043            494       .4840          60.6520       52.6971     20860.6520     5:47: 40.6520
        0044            496       .4850          61.1360       53.2687     20861.1360     5:47: 41.1360
        0045            498       .4880          61.6210       53.8446     20861.6210     5:47: 41.6210
        0046            496       .4850          62.1090       54.4214     20862.1090     5:47: 42.1090
        0047            504       .4940          62.5940       54.9926     20862.5940     5:47: 42.5940
        0048            506       .4850          63.0880       55.5721     20863.0880     5:47: 43.0880
        0049            500       .4900          63.5730       56.1383     20863.5730     5:47: 43.5730
        0050            494       .4830          64.0630       56.7012     20864.0630     5:47: 44.0630
        0051            498       .4880          64.5460       57.2652     20864.5460     5:47: 44.5460
        0052            496       .4860          65.0340       57.8378     20865.0340     5:47: 45.0340
        0053            504       .4930          65.5200       58.3918     20865.5200     5:47: 45.5200
        0054            499       .4880          66.0130       58.9567     20866.0130     5:47: 46.0130
        0055            496       .4850          66.5010       59.5135     20866.5010     5:47: 46.5010
        0056            499       .4875          66.9860       60.0647     20866.9860     5:47: 46.9860
        0057            499       .4875          67.4735       60.6165     20867.4735     5:47: 47.4735
        0058            499       .4885          67.9610       61.1651     20867.9610     5:47: 47.9610
        0059            499       .4885          68.4495       61.7146     20868.4495     5:47: 48.4495
        0060            499       .4880          68.9380       62.2619     20868.9380     5:47: 48.9380
        0061            499       .4870          69.4260       62.8083     20869.4260     5:47: 49.4260
        0062            508       .4980          69.9130       63.3414     20869.9130     5:47: 49.9130
        0063            502       .4910          70.4110       63.8944     20870.4110     5:47: 50.4110
        0064            502       .4920          70.9020       64.4343     20870.9020     5:47: 50.9020
        0065            504       .4930          71.3940       64.9772     20871.3940     5:47: 51.3940
        0066            495       .4840          71.8870       65.5108     20871.8870     5:47: 51.8870
        0067            494       .4830          72.3710       66.0346     20872.3710     5:47: 52.3710
        0068            498       .4880          72.8540       66.5587     20872.8540     5:47: 52.8540
        0069            496       .4830          73.3420       67.0881     20873.3420     5:47: 53.3420
        0070            508       .4980          73.8250       67.6090     20873.8250     5:47: 53.8250
        0071            495       .4850          74.3230       68.1337     20874.3230     5:47: 54.3230
        0072            499       .4880          74.8080       68.6493     20874.8080     5:47: 54.8080
        0073            494       .4830          75.2960       69.1658     20875.2960     5:47: 55.2960
        0074            509       .4980          75.7790       69.6769     20875.7790     5:47: 55.7790
        0075            494       .4830          76.2770       70.2034     20876.2770     5:47: 56.2770
        0076            496       .4860          76.7600       70.7020     20876.7600     5:47: 56.7600
        0077            496       .4860          77.2460       71.2075     20877.2460     5:47: 57.2460
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EXCEDE II  MS-2  SPECTRAL SWEEP STARTS                                                    05/02/80  13.37.41.        PAGE    2

   SPECTRAL S        LENGTH   LENGTH SEC     TIME A.L.     ALTITUDE      TIME U.T.   UT CLOCK TIME
      0078             492      .4810         77.7320       71.7108     20877.7320   5:47: 57.7320
      0079             496      .4860         78.2130       72.2067     20878.2130   5:47: 58.2130
      0080             497      .4830         78.6950       72.7055     20878.6950   5:47: 58.6950
      0081             494      .4840         79.1820       73.1912     20879.1820   5:47: 59.1820
      0082             494      .4840         79.6660       73.6916     20879.6660   5:47: 59.6660
      0083             494      .4830         80.1500       74.1818     20880.1500   5:48:   .1500
      0084             494      .4840         80.6330       74.5688     20880.6330   5:48:   .6330
      0085             494      .4830         81.1170       75.1566     20881.1170   5:48:  1.1170
     -0086             495      .4850         81.6000       75.6372     20881.6000   5:48:  1.6000
     -0087             495      .4850         82.0850       76.1197     20882.0850   5:48:  2.0850
      0088             496      .4850         82.5700       76.5819     20882.5700   5:48:  2.5700
      0089             495      .4840         83.0550       77.0779     20883.0550   5:48:  3.0550
      0090             494      .4830         83.5390       77.5517     20883.5390   5:48:  3.5390
      0091             495      .4840         84.0220       78.0263     20884.0220   5:48:  4.0220
      0092             492      .4820         84.5060       78.4917     20884.5060   5:48:  4.5060
      0093             496      .4850         84.9880       78.9610     20884.9880   5:48:  4.9880
      0094             495      .4840         85.4730       79.4280     20885.4730   5:48:  5.4730
      0095             494      .4830         85.9570       79.8918     20885.9570   5:48:  5.9570
      0096             497      .4870         86.4400       80.3574     20886.4400   5:48:  6.4400
      0097             496      .4860         86.9220       80.8100     20886.9220   5:48:  6.9220
      0098             492      .4810         87.4080       81.2691     20887.4080   5:48:  7.4080
      0099             495      .4860         87.8890       81.7213     20887.8890   5:48:  7.8890
      0100             492      .4810         88.3750       82.1760     20888.3750   5:48:  8.3750
      0101             495      .4840         88.8560       82.6218     20888.8560   5:48:  8.8560
      0102             495      .4830         89.3400       83.0712     20889.3400   5:48:  9.3400
      0103             494      .4840         89.8230       83.5175     20889.8230   5:48:  9.8230
      0104             495      .4840         90.3070       83.9615     20890.3070   5:48: 10.3070
      0105             494      .4830         90.7910       84.4074     20890.7910   5:48: 10.7910
      0106             494      .4840         91.2740       84.8421     20891.2740   5:48: 11.2740
      0107             492      .4810         91.7580       85.2796     20891.7580   5:48: 11.7580
     -0108             495      .4850         92.2390       85.7131     20892.2390   5:48: 12.2390
     -0109             495      .4850         92.7240       86.1461     20892.7240   5:48: 12.7240
      0110             492      .4810         93.2090       86.5778     20893.2090   5:48: 13.2090
      0111             492      .4820         93.6900       87.0018     20893.6900   5:48: 13.6900
      0112             493      .4830         94.1720       87.4275     20894.1720   5:48: 14.1720
      0113             498      .4880         94.6550       87.8559     20894.6550   5:48: 14.6550
      0114             492      .4810         95.1430       88.2724     20895.1430   5:48: 15.1430
      0115             494      .4840         95.6240       88.6947     20895.6240   5:48: 15.6240
      0116             494      .4840         96.1080       89.1173     20896.1080   5:48: 16.1080
      0117             494      .4830         96.5920       89.5278     20896.5920   5:48: 16.5920
      0118             494      .4840         97.0750       89.9402     20897.0750   5:48: 17.0750
      0119             496      .4850         97.5590       90.3513     20897.5590   5:48: 17.5590
      0120             495      .4860         98.0440       90.7610     20898.0440   5:48: 18.0440
      0121             492      .4810         98.5300       91.1693     20898.5300   5:48: 18.5300
     -0122             495      .4850         99.0110       91.5712     20899.0110   5:48: 19.0110
     -0123             495      .4850         99.4960       91.9713     20899.4960   5:48: 19.4960
      0124             495      .4830         99.9810       92.3702     20899.9810   5:48: 19.9810
      0125             496      .4860        100.4640       92.7732     20900.4640   5:48: 20.4640
      0126             494      .4830        100.9500       93.1615     20900.9500   5:48: 20.9500
     -0127             494      .4835        101.4330       93.5612     20901.4330   5:48: 21.4330
     -0128             494      .4875        101.9165       93.9570     20901.9165   5:48: 21.9165
      0129             492      .4820        102.4000       94.3416     20902.4000   5:48: 22.4000
      0130             494      .4830        102.8820       94.7263     20902.8820   5:48: 22.8820
      0131             494      .4840        103.3650       95.1118     20903.3650   5:48: 23.3650
      0132             492      .4820        103.8490       95.4912     20903.8490   5:48: 23.8490
     -0133             495      .4845        104.3310       95.8719     20904.3310   5:48: 24.3310
     -0134             495      .4845        104.8155       96.2514     20904.8155   5:48: 24.8155
      0135             492      .4810        105.3000       96.6266     20905.3000   5:48: 25.3000
      0136             495      .4860        105.7810       96.9980     20905.7810   5:48: 25.7810
      0137             494      .4830        106.2670       97.3710     20906.2670   5:48: 26.2670
      0138             494      .4840        106.7500       97.7395     20906.7500   5:48: 26.7500
      0139             492      .4810        107.2340       98.1036     20907.2340   5:48: 27.2340
      0140             496      .4860        107.7150       98.4692     20907.7150   5:48: 27.7150
      0141             492      .4810        108.2010       98.8314     20908.2010   5:48: 28.2010
      0142             496      .4860        108.6820       99.1915     20908.6820   5:48: 28.6820
      0143             492      .4820        109.1680       99.5514     20909.1680   5:48: 29.1680
      0144             495      .4830        109.6500       99.9050     20909.6500   5:48: 29.6500
      0145             494      .4840        110.1330      100.2572     20910.1330   5:48: 30.1330
      0146             494      .4830        110.6170      100.6109     20910.6170   5:48: 30.6170
      0147             495      .4860        111.1000      100.9566     20911.1000   5:48: 31.1000
      0148             492      .4810        111.5860      101.3034     20911.5860   5:48: 31.5860
      0149             496      .4860        112.0670      101.6513     20912.0670   5:48: 32.0670
      0150             494      .4830        112.5530      101.9916     20912.5530   5:48: 32.5530
      0151             494      .4840        113.0360      102.3316     20913.0360   5:48: 33.0360
      0152             495      .4830        113.5200      102.6711     20913.5200   5:48: 33.5200
      0153             494      .4840        114.0030      103.0007     20914.0030   5:48: 34.0030
      0154             494      .4830        114.4870      103.3419     20914.4870   5:48: 34.4870
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EXCEDE II  NS-6  SPECTRAL SWEEP STARTS                                    05/02/80  13.37.41.          PAGE    3

    SPECTRAL S      LENGTH   LENGTH SEC    TIME A.L.     ALTITUDE      TIME L.T.     UT CLOCK TIME
          0155        492       .4820      114.9700      103.6750     20914.9700     5:48: 34.9700
          0156        494       .4830      115.4520      104.0034     20915.4520     5:48: 35.4520
          0157        496       .4860      115.9350      104.3392     20915.9350     5:48: 35.9350
          0158        492       .4820      116.4210      104.6568     20916.4210     5:48: 36.4210
          0159        492       .4810      116.9020      104.9786     20916.9020     5:48: 36.9020
          0160        496       .4860      117.3840      105.2975     20917.3840     5:48: 37.3840
          0161        494       .4830      117.8700      105.6176     20917.8700     5:48: 37.8700
          0162        496       .4840      118.3530      105.9374     20918.3530     5:48: 38.3530
         -0163        494       .4833      118.8370      106.2478     20918.8370     5:48: 38.8370
         -0164        494       .4833      119.3203      106.5594     20919.3203     5:48: 39.3203
         -0165        494       .4833      119.8037      106.86 9     20919.8037     5:48: 39.8037
          0166        492       .4820      120.2870      107.17 2     20920.2870     5:48: 40.2870
          0167        494       .4830      120.7690      107.48 5     20920.7690     5:48: 40.7690
          0168        494       .4840      121.2520      107.78 2     20921.2520     5:48: 41.2520
          0169        498       .4870      121.7360      108.0843     20921.7360     5:48: 41.7360
          0170        492       .4820      122.2230      108.3851     20922.2230     5:48: 42.2230
          0171        494       .4830      122.7050      108.68 5     20922.7050     5:48: 42.7050
          0172        492       .4820      123.1880      108.97 6     20923.1880     5:48: 43.1880
          0173        498       .4870      123.6700      109.26 7     20923.6700     5:48: 43.6700
          0174        494       .4840      124.1570      109.5576     20924.1570     5:48: 44.1570
          0175        496       .4850      124.6410      109.84 5     20924.6410     5:48: 44.6410
          0176        494       .4840      125.1260      110.13 9     20925.1260     5:48: 45.1260
          0177        494       .4830      125.6100      110.4154     20925.6100     5:48: 45.6100
          0178        496       .4860      126.0930      110.5961     20926.0930     5:48: 46.0930
          0179        492       .4810      126.5790      110.9764     20926.5790     5:48: 46.5790
          0180        494       .4840      127.0600      111.2516     20927.0600     5:48: 47.0600
          0181        492       .4810      127.5440      111.5263     20927.5440     5:48: 47.5440
          0182        494       .4840      128.0250      111.7972     20928.0250     5:48: 48.0250
         -0183        495       .4845      128.5090      112.0675     20928.5090     5:48: 48.5090
         -0184        495       .4845      128.9935      112.3359     20928.9935     5:48: 48.9935
          0185        496       .4850      129.4780      112.50 2     20929.4780     5:48: 49.4780
          0186        492       .4820      129.9630      112.8654     20929.9630     5:48: 49.9630
          0187        496       .4850      130.4450      113.1269     20930.4450     5:48: 50.4450
          0188        492       .4820      130.9300      113.3868     20930.9300     5:48: 50.9300
          0189        494       .4830      131.4120      113.64 8     20931.4120     5:48: 51.4120
          0190        494       .4840      131.8950      113.8973     20931.8950     5:48: 51.8950
          0191        492       .4810      132.3790      114.1540     20932.3790     5:48: 52.3790
         -0192        495       .4845      132.8600      114.3930     20932.8600     5:48: 52.8600
         -0193        495       .4845      133.3445      114.6476     20933.3445     5:48: 53.3445
          0194        494       .4840      133.8290      114.8940     20933.8290     5:48: 53.8290
          0195        494       .4830      134.3130      115.1380     20934.3130     5:48: 54.3130
          0196        496       .4860      134.7960      115.3792     20934.7960     5:48: 54.7960
          0197        492       .4810      135.2820      115.61 8     20935.2820     5:48: 55.2820
          0198        496       .4860      135.7630      115.85 7     20935.7630     5:48: 55.7630
          0199        494       .4830      136.2490      116.0918     20936.2490     5:48: 56.2490
          0200        494       .4840      136.7320      116.3243     20936.7320     5:48: 56.7320
          0201        494       .4830      137.2160      116.5550     20937.2160     5:48: 57.2160
          0202        494       .4840      137.6990      116.78 1     20937.6990     5:48: 57.6990
          0203        492       .4810      138.1830      117.0094     20938.1830     5:48: 58.1830
          0204        496       .4860      138.6640      117.23 2     20938.6640     5:48: 58.6640
          0205        492       .4810      139.1500      117.4551     20939.1500     5:48: 59.1500
          0206        496       .4860      139.6310      117.6735     20939.6310     5:48: 59.6310
          0207        494       .4830      140.1170      117.8920     20940.1170     5:49:   .1170
          0208        494       .4840      140.6000      118.1069     20940.6000     5:49:   .6000
          0209        492       .4810      141.0840      118.3201     20941.0840     5:49:  1.0840
          0210        496       .4860      141.5650      118.5297     20941.5650     5:49:  1.5650
          0211        494       .4830      142.0510      118.7314     20942.0510     5:49:  2.0510
          0212        498       .4880      142.5340      118.9455     20942.5340     5:49:  2.5340
          0213        494       .4830      143.0220      119.1516     20943.0220     5:49:  3.0220
          0214        492       .4820      143.5050      119.35 3     20943.5050     5:49:  3.5050
          0215        494       .4830      143.9870      119.5526     20943.9870     5:49:  3.9870
          0216        494       .4840      144.4700      119.74 8     20944.4700     5:49:  4.4700
          0217        498       .4870      144.9540      119.94 4     20944.9540     5:49:  4.9540
         -0218        493       .4825      145.4410      120.13 9     20945.4410     5:49:  5.4410
         -0219        493       .4825      145.9235      120.33 5     20945.9235     5:49:  5.9235
          0220        496       .4850      146.4060      120.5169     20946.4060     5:49:  6.4060
          0221        494       .4840      146.8910      120.7070     20946.8910     5:49:  6.8910
          0222        496       .4850      147.3750      120.89 6     20947.3750     5:49:  7.3750
          0223        492       .4820      147.8600      121.0733     20947.8600     5:49:  7.8600
          0224        494       .4830      148.3420      121.2528     20948.3420     5:49:  8.3420
          0225        496       .4860      148.8250      121.4304     20948.8250     5:49:  8.8250
          0226        494       .4830      149.3110      121.6053     20949.3110     5:49:  9.3110
          0227        494       .4840      149.7940      121.78 1     20949.7940     5:49:  9.7940
          0228        499       .4870      150.2780      121.9514     20950.2780     5:49: 10.2780
         -0229        493       .4825      150.7650      122.1216     20950.7650     5:49: 10.7650
         -0230        493       .4825      151.2475      122.2881     20951.2475     5:49: 11.2475
          0231        498       .4870      151.7300      122.4523     20951.7300     5:49: 11.7300
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EXCEDE II  HS-6  SPECTRAL SU ER STARTS                                               06/02/80  13.37.41.          PAGE    4

  SPECTRAL S       LENGTH   LENGTH SEC     TIME A.L.      ALTITUDE       TIME U.T.     UT CLOCK TIME
       0232          482      .4820        152.2170       122.5159      20952.2170     5149: 12.2170
      -0233          484      .4840        152.6990       122.7756      20952.6990     5149: 12.6990
      -0234          484      .4840        153.1830       122.9337      20953.1830     5149: 13.1830
      -0235          484      .4840        153.6670       123.0897      20953.6670     5149: 13.6670
      -0236          484      .4835        154.1510       123.2434      20954.1510     5149: 14.1510
      -0237          484      .4835        154.6345       123.3948      20954.6345     5149: 14.6345
       0238          484      .4840        155.1180       123.5440      20955.1180     5149: 15.1180
       0239          484      .4840        155.6020       123.6912      20955.6020     5149: 15.6020
       0240          498      .4980        156.0860       123.8362      20956.0860     5149: 16.0860
       0241          492      .4920        156.5840       123.9830      20956.5840     5149: 16.5840
       0242          496      .4960        157.0760       124.1258      20957.0760     5149: 17.0760
       0243          494      .4940        157.5720       124.2675      20957.5720     5149: 17.5720
       0244          496      .4960        158.0660       124.4062      20958.0660     5149: 18.0660
       0245          494      .4940        158.5620       124.5433      20958.5620     5149: 18.5620
       0246          494      .4940        159.0560       124.6775      20959.0560     5149: 19.0560
       0247          494      .4940        159.5500       124.8096      20959.5500     5149: 19.5500
       0248          494      .4940        160.0440       124.9390      20960.0440     5149: 20.0440
       0249          494      .4940        160.5380       125.0663      20960.5380     5149: 20.5380
       0250          494      .4940        161.0320       125.1933      20961.0320     5149: 21.0320
       0251          492      .4920        161.5260       125.3141      20961.5260     5149: 21.5260
      -0252          496      .4960        162.0180       125.4340      20962.0180     5149: 22.0180
      -0253          496      .4960        162.5140       125.5526      20962.5140     5149: 22.5140
       0254          492      .4920        163.0100       125.6690      20963.0100     5149: 23.0100
       0255          496      .4960        163.5020       125.7831      20963.5020     5149: 23.5020
       0256          494      .4940        163.9980       125.8978      20963.9980     5149: 23.9980
       0257          494      .4940        164.4920       126.0027      20964.4920     5149: 24.4920
       0258          492      .4920        164.9860       126.1034      20964.9860     5149: 24.9860
       0259          494      .4940        165.4780       126.2124      20965.4780     5149: 25.4780
       0260          494      .4940        165.9720       126.3105      20965.9720     5149: 25.9720
       0261          494      .4940        166.4660       126.4133      20966.4660     5149: 26.4660
       0262          494      .4940        166.9600       126.5128      20966.9600     5149: 26.9600
       0263          496      .4960        167.4540       126.6080      20967.4540     5149: 27.4540
       0264          494      .4940        167.9500       126.7013      20967.9500     5149: 27.9500
       0265          496      .4960        168.4440       126.7919      20968.4440     5149: 28.4440
       0266          494      .4940        168.9400       126.8826      20968.9400     5149: 28.9400
       0267          496      .4960        169.4340       126.9567      20969.4340     5149: 29.4340
       0268          494      .4940        169.9300       127.0507      20969.9300     5149: 29.9300
       0269          492      .4920        170.4240       127.1322      20970.4240     5149: 30.4240
       0270          496      .4960        170.9160       127.2110      20970.9160     5149: 30.9160
       0271          492      .4920        171.4120       127.2862      20971.4120     5149: 31.4120
       0272          496      .4960        171.9040       127.3614      20971.9040     5149: 31.9040
       0273          494      .4940        172.4000       127.4330      20972.4000     5149: 32.4000
       0274          496      .4960        172.8940       127.5020      20972.8940     5149: 32.8940
       0275          494      .4940        173.3900       127.5719      20973.3900     5149: 33.3900
       0276          494      .4940        173.8840       127.6383      20973.8840     5149: 33.8840
       0277          492      .4920        174.3780       127.7014      20974.3780     5149: 34.3780
       0278          496      .4960        174.8700       127.7670      20974.8700     5149: 34.8700
       0279          494      .4940        175.3660       127.8207      20975.3660     5149: 35.3660
       0280          494      .4940        175.8600       127.8769      20975.8600     5149: 35.8600
       0281          496      .4960        176.3540       127.9308      20976.3540     5149: 36.3540
       0282          494      .4940        176.8500       127.9827      20976.8500     5149: 36.8500
       0283          494      .4940        177.3440       128.0330      20977.3440     5149: 37.3440
       0284          496      .4960        177.8380       128.0790      20977.8380     5149: 37.8380
       0285          500      .5000        178.3340       128.1239      20978.3340     5149: 38.3340
       0286          494      .4940        178.8340       128.1669      20978.8340     5149: 38.8340
       0287          494      .4940        179.3280       128.2070      20979.3280     5149: 39.3280
       0288          492      .4920        179.8220       128.2449      20979.8220     5149: 39.8220
       0289          494      .4940        180.3140       128.2802      20980.3140     5149: 40.3140
       0290          496      .4960        180.8080       128.3135      20980.8080     5149: 40.8080
       0291          494      .4940        181.3040       128.3446      20981.3040     5149: 41.3040
       0292          492      .4920        181.7980       128.3732      20981.7980     5149: 41.7980
       0293          498      .4980        182.2900       128.3995      20982.2900     5149: 42.2900
       0294          494      .4940        182.7880       128.4237      20982.7880     5149: 42.7880
       0295          496      .4960        183.2820       128.4465      20983.2820     5149: 43.2820
       0296          494      .4940        183.7780       128.4671      20983.7780     5149: 43.7780
       0297          492      .4920        184.2720       128.4862      20984.2720     5149: 44.2720
       0298          498      .4980        184.7640       128.4971      20984.7640     5149: 44.7640
       0299          494      .4940        185.2620       128.5018      20985.2620     5149: 45.2620
       0300          492      .4920        185.7560       128.5200      20985.7560     5149: 45.7560
       0301          496      .4960        186.2480       128.5290      20986.2480     5149: 46.2480
       0302          494      .4940        186.7440       128.5377      20986.7440     5149: 46.7440
       0303          494      .4940        187.2380       128.5371      20987.2380     5149: 47.2380
       0304          492      .4920        187.7320       128.5393      20987.7320     5149: 47.7320
       0305          496      .4960        188.2240       128.5371      20988.2240     5149: 48.2240
       0306          492      .4920        188.7200       128.5336      20988.7200     5149: 48.7200
       0307          496      .4960        189.2120       128.5279      20989.2120     5149: 49.2120
       0308          496      .4960        189.7080       128.5139      20989.7080     5149: 49.7080
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EXCEDE II  MS-6  SPECTRAL SWEEP STARTS                                          05/02/80  13.37.41.          PAGE    5

   SPECTRAL #        LENGTH   LENGTH SEC     TIME A.L.      ALTITUDE       TIME U.T.     UT CLOCK TIME
        0309           492       .4920        190.2020      128.5095      20990.2020     5:49: 50.2020
        0310           496       .4960        190.6940      128.4919      20990.6940     5:49: 50.6940
        0311           494       .4940        191.1900      128.4819      20991.1900     5:49: 51.1900
        0312           495       .4950        191.6840      128.4667      20991.6840     5:49: 51.6840
        0313           495       .4950        192.1790      128.4451      20992.1790     5:49: 52.1790
        0314           492       .4920        192.6740      128.4213      20992.6740     5:49: 52.6740
        0315           494       .4940        193.1660      128.3973      20993.1660     5:49: 53.1660
        0316           495       .4950        193.6600      128.3729      20993.6600     5:49: 53.6600
        0317           495       .4950        194.1550      128.3441      20994.1550     5:49: 54.1550
        0318           494       .4940        194.6500      128.3131      20994.6500     5:49: 54.6500
        0319           494       .4940        195.1440      128.2798      20995.1440     5:49: 55.1440
        0320           492       .4920        195.6380      128.2442      20995.6380     5:49: 55.6380
        0321           495       .4950        196.1300      128.2065      20996.1300     5:49: 56.1300
        0322           495       .4950        196.6250      128.1663      20996.6250     5:49: 56.6250
        0323           492       .4920        197.1200      128.1238      20997.1200     5:49: 57.1200
        0324           498       .4980        197.6120      128.0792      20997.6120     5:49: 57.6120
        0325           494       .4940        198.1100      128.0328      20998.1100     5:49: 58.1100
        0326           494       .4940        198.6040      127.9845      20998.6040     5:49: 58.6040
        0327           494       .4940        199.0980      127.9339      20999.0980     5:49: 59.0980
        0328           492       .4920        199.5920      127.8799      20999.5920     5:49: 59.5920
        0329           498       .4980        200.0840      127.8229      21000.0840     5:50:   .0840
        0330           493       .4930        200.5820      127.7620      21000.5820     5:50:   .5820
        0331           493       .4930        201.0750      127.7013      21001.0750     5:50:  1.0750
        0332           495       .4950        201.5680      127.6383      21001.5680     5:50:  1.5680
        0333           495       .4950        202.0630      127.5728      21002.0630     5:50:  2.0630
        0334           496       .4960        202.5580      127.5054      21002.5580     5:50:  2.5580
        0335           494       .4940        203.0540      127.4367      21003.0540     5:50:  3.0540
        0336           492       .4920        203.5480      127.3624      21003.5480     5:50:  3.5480
        0337           498       .4980        204.0400      127.2882      21004.0400     5:50:  4.0400
        0338           492       .4920        204.5380      127.2117      21004.5380     5:50:  4.5380
        0339           498       .4980        205.0300      127.1319      21005.0300     5:50:  5.0300
        0340           492       .4920        205.5280      127.0497      21005.5280     5:50:  5.5280
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        0342           492       .4920        206.5180      126.8786      21006.5180     5:50:  6.5180
        0343           494       .4940        207.0100      126.7906      21007.0100     5:50:  7.0100
        0344           496       .4960        207.5040      126.7009      21007.5040     5:50:  7.5040
        0345           494       .4940        208.0000      126.6076      21008.0000     5:50:  8.0000
        0346           494       .4940        208.4940      126.5124      21008.4940     5:50:  8.4940
        0347           496       .4960        208.9880      126.4149      21008.9880     5:50:  8.9880
        0348           496       .4960        209.4840      126.3147      21009.4840     5:50:  9.4840
        0349           494       .4940        209.9800      126.2121      21009.9800     5:50:  9.9800
        0350           494       .4940        210.4740      126.1072      21010.4740     5:50: 10.4740
        0351           494       .4940        210.9680      126.0010      21010.9680     5:50: 10.9680
        0352           494       .4940        211.4620      125.8920      21011.4620     5:50: 11.4620
        0353           494       .4940        211.9560      125.7807      21011.9560     5:50: 11.9560
        0354           494       .4940        212.4500      125.6671      21012.4500     5:50: 12.4500
        0355           494       .4940        212.9440      125.5512      21012.9440     5:50: 12.9440
        0356           492       .4920        213.4380      125.4330      21013.4380     5:50: 13.4380
        0357           496       .4960        213.9300      125.3131      21013.9300     5:50: 13.9300
        0358           492       .4920        214.4260      125.1899      21014.4260     5:50: 14.4260
        0359           496       .4960        214.9180      125.0651      21014.9180     5:50: 14.9180
        0360           494       .4940        215.4140      124.9374      21015.4140     5:50: 15.4140
        0361           494       .4940        215.9080      124.8078      21015.9080     5:50: 15.9080
        0362           494       .4940        216.4020      124.6759      21016.4020     5:50: 16.4020
        0363           492       .4920        216.8960      124.5416      21016.8960     5:50: 16.8960
        0364           494       .4940        217.3880      124.4047      21017.3880     5:50: 17.3880
        0365           494       .4940        217.8820      124.2653      21017.8820     5:50: 17.8820
        0366           496       .4960        218.3760      124.1238      21018.3760     5:50: 18.3760
        0367           498       .4980        218.8720      123.9818      21018.8720     5:50: 18.8720
        0368           494       .4940        219.3700      123.8370      21019.3700     5:50: 19.3700
        0369           494       .4940        219.8640      123.6899      21019.8640     5:50: 19.8640
        0370           492       .4920        220.3580      123.5397      21020.3580     5:50: 20.3580
        0371           494       .4940        220.8500      123.3867      21020.8500     5:50: 20.8500
        0372           496       .4960        221.3440      123.2289      21021.3440     5:50: 21.3440
        0373           492       .4920        221.8400      123.0721      21021.8400     5:50: 21.8400
        0374           494       .4940        222.3320      122.9133      21022.3320     5:50: 22.3320
        0375           496       .4960        222.8260      122.7515      21022.8260     5:50: 22.8260
        0376           494       .4940        223.3220      122.5918      21023.3220     5:50: 23.3220
        0377           494       .4940        223.8160      122.4245      21023.8160     5:50: 23.8160
        0378           492       .4920        224.3100      122.2513      21024.3100     5:50: 24.3100
        0379           496       .4960        224.8020      122.0816      21024.8020     5:50: 24.8020
        0380           494       .4940        225.2980      121.9077      21025.2980     5:50: 25.2980
        0381           495       .4950        225.7920      121.7312      21025.7920     5:50: 25.7920
        0382           495       .4950        226.2870      121.5541      21026.2870     5:50: 26.2870
        0383           494       .4940        226.7820      121.3736      21026.7820     5:50: 26.7820
        0384           496       .4960        227.2760      121.1912      21027.2760     5:50: 27.2760
        0385           492       .4920        227.7720      121.0058      21027.7720     5:50: 27.7720
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EXCEDE II  MS-4  SPECTRAL SWEEP STARTS                                              05/02/80  13.37.41.        PAGE    6
      SPECTRAL S        LENGTH   LENGTH SEC    TIME A.L.    ALTITUDE     TIME U.T.    UT CLOCK TIME
          3386           496       .4960       228.2640     120.9195    21028.2640    5:50: 28.2640
          3387           494       .4940       228.7600     120.5225    21028.7600    5:50: 28.7600
          3388           494       .4940       229.2540     120.4379    21029.2540    5:50: 29.2540
          3389           492       .4920       229.7460     120.2441    21029.7460    5:50: 29.7460
          3390           496       .4960       230.2400     120.0487    21030.2400    5:50: 30.2400
          3391           494       .4940       230.7360     119.8495    21030.7360    5:50: 30.7360
          3392           494       .4940       231.2300     119.6497    21031.2300    5:50: 31.2300
          3393           496       .4960       231.7240     119.4487    21031.7240    5:50: 31.7240
          3394           492       .4920       232.2200     119.2335    21032.2200    5:50: 32.2200
          3395           496       .4960       232.7120     119.0378    21032.7120    5:50: 32.7120
          3396           496       .4960       233.2080     118.8320    21033.2080    5:50: 33.2080
          3397           494       .4940       233.7020     118.5018    21033.7020    5:50: 33.7020
          3398           492       .4920       234.1960     118.3963    21034.1960    5:50: 34.1960
          3399           498       .4980       234.6880     118.1764    21034.6880    5:50: 34.6880
         -3400           494       .4940       235.1860     117.9505    21035.1860    5:50: 35.1860
         -3401           494       .4940       235.6800     117.7371    21035.6800    5:50: 35.6800
          3402           496       .4960       236.1740     117.5174    21036.1740    5:50: 36.1740
         -3403           354       .3470       236.6700     117.2865    21036.6700    5:50: 36.6700
         -3404           354       .3470       237.0170     117.1274    21037.0170    5:50: 37.0170
         -3405           494       .4835       237.3640     116.9652    21037.3640    5:50: 37.3640
         -3406           494       .4835       237.8475     116.7356    21037.8475    5:50: 37.8475
          3407           492       .4810       238.3310     116.5059    21038.3310    5:50: 38.3310
          3408           494       .4840       238.8120     116.2811    21038.8120    5:50: 38.8120
          3409           496       .4850       239.2960     116.0498    21039.2960    5:50: 39.2960
          3410           492       .4820       239.7810     115.8187    21039.7810    5:50: 39.7810
          3411           496       .4850       240.2630     115.5739    21040.2630    5:50: 40.2630
          3412           494       .4830       240.7480     115.3374    21040.7480    5:50: 40.7480
          3413           494       .4840       241.2310     115.0918    21041.2310    5:50: 41.2310
          3414           494       .4830       241.7150     114.8476    21041.7150    5:50: 41.7150
          3415           494       .4830       242.1980     114.6013    21042.1980    5:50: 42.1980
          3416           494       .4840       242.6810     114.3531    21042.6810    5:50: 42.6810
          3417           494       .4830       243.1650     114.1021    21043.1650    5:50: 43.1650
          3418           494       .4830       243.6480     113.8495    21043.6480    5:50: 43.6480
          3419           494       .4840       244.1310     113.5956    21044.1310    5:50: 44.1310
          3420           496       .4850       244.6150     113.3371    21044.6150    5:50: 44.6150
          3421           492       .4820       245.1000     113.0769    21045.1000    5:50: 45.1000
          3422           496       .4850       245.5820     112.8159    21045.5820    5:50: 45.5820
         -3423           496       .4855       246.0670     112.5552    21046.0670    5:50: 46.0670
         -3424           496       .4855       246.5525     112.2840    21046.5525    5:50: 46.5525
          3425           492       .4810       247.0380     112.0146    21047.0380    5:50: 47.0380
          3426           494       .4830       247.5190     111.7455    21047.5190    5:50: 47.5190
          3427           498       .4880       248.0020     111.4721    21048.0020    5:50: 48.0020
          3428           496       .4830       248.4900     111.1977    21048.4900    5:50: 48.4900
          3429           494       .4830       248.9730     110.9149    21048.9730    5:50: 48.9730
          3430           494       .4840       249.4560     110.6339    21049.4560    5:50: 49.4560
          3431           492       .4810       249.9400     110.3561    21049.9400    5:50: 49.9400
          3432           496       .4850       250.4210     110.0719    21050.4210    5:50: 50.4210
          3433           494       .4840       250.9060     109.7802    21050.9060    5:50: 50.9060
          3434           494       .4830       251.3900     109.5018    21051.3900    5:50: 51.3900
          3435           492       .4820       251.8730     109.2139    21051.8730    5:50: 51.8730
          3436           496       .4850       252.3550     108.9193    21052.3550    5:50: 52.3550
          3437           494       .4830       252.8400     108.6238    21052.8400    5:50: 52.8400
          3438           494       .4840       253.3230     108.3272    21053.3230    5:50: 53.3230
          3439           496       .4850       253.8070     108.0279    21053.8070    5:50: 53.8070
         -3440           494       .4835       254.2920     107.7257    21054.2920    5:50: 54.2920
         -3441           494       .4835       254.7755     107.4223    21054.7755    5:50: 54.7755
          3442           496       .4850       255.2590     107.1166    21055.2590    5:50: 55.2590
          3443           494       .4830       255.7440     106.8079    21055.7440    5:50: 55.7440
          3444           494       .4840       256.2270     106.4991    21056.2270    5:50: 56.2270
          3445           494       .4830       256.7110     106.1856    21056.7110    5:50: 56.7110
          3446           494       .4830       257.1940     105.8715    21057.1940    5:50: 57.1940
          3447           494       .4840       257.6770     105.5572    21057.6770    5:50: 57.6770
          3448           490       .4870       258.1610     105.2340    21058.1610    5:50: 58.1610
          3449           494       .4830       258.6480     104.9127    21058.6480    5:50: 58.6480
          3450           492       .4820       259.1310     104.5958    21059.1310    5:50: 59.1310
          3451           496       .4850       259.6130     104.2674    21059.6130    5:50: 59.6130
          3452           496       .4830       260.0980     103.9377    21060.0980    5:51:   .0980
          3453           492       .4820       260.5810     103.6073    21060.5810    5:51:   .5810
          3454           496       .4850       261.0630     103.2763    21061.0630    5:51:  1.0630
          3455           494       .4840       261.5480     102.9441    21061.5480    5:51:  1.5480
          3456           494       .4830       262.0320     102.6043    21062.0320    5:51:  2.0320
          3457           494       .4830       262.5150     102.2651    21062.5150    5:51:  2.5150
          3458           494       .4840       262.9980     101.9216    21062.9980    5:51:  2.9980
          3459           496       .4850       263.4820     101.5823    21063.4820    5:51:  3.4820
          3460           494       .4830       263.9670     101.2351    21063.9670    5:51:  3.9670
          3461           494       .4840       264.4500     100.8830    21064.4500    5:51:  4.4500
         -3462           496       .4840       264.9340     100.5301    21064.9340    5:51:  4.9340
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EXCEDE II  NS-6  SPECTRAL SWEEP STARTS                                                        05/02/80  13.37.41.          PAGE    7
 SPECTRAL S     LENGTH  LENGTH SEC   TIME A.L.    ALTITUDE     TIME U.T.   UT CLOCK TIME
    -0463        495      .4840      265.4180     100.1339    21065.4180   5:51:   5.4180
     0464        492      .4820      265.9020      99.9336    21065.9020   5:51:   5.9020
     0465        494      .4830      266.3840      99.4775    21066.3840   5:51:   6.3840
     0466        498      .4870      266.8670      99.1135    21066.8670   5:51:   6.8670
     0467        496      .4860      267.3540      98.7564    21067.3540   5:51:   7.3540
     0468        496      .4850      267.8400      98.3917    21067.8400   5:51:   7.8400
     0469        496      .4850      268.3250      98.0256    21068.3250   5:51:   8.3250
     0470        497      .4820      268.8100      97.5573    21068.8100   5:51:   8.8100
     0471        496      .4850      269.2920      97.2891    21069.2920   5:51:   9.2920
     0472        492      .4810      269.7770      96.9113    21069.7770   5:51:   9.7770
     0473        498      .4870      270.2580      96.5465    21070.2580   5:51:  10.2580
     0474        494      .4840      270.7450      96.1678    21070.7450   5:51:  10.7450
     0475        492      .4810      271.2290      95.7872    21071.2290   5:51:  11.2290
     0476        496      .4850      271.7100      95.4088    21071.7100   5:51:  11.7100
     0477        492      .4820      272.1950      95.0221    21072.1950   5:51:  12.1950
     0478        495      .4850      272.6770      94.5615    21072.6770   5:51:  12.6770
     0479        492      .4820      273.1620      94.2514    21073.1620   5:51:  13.1620
     0480        496      .4850      273.6440      93.8655    21073.6440   5:51:  13.6440
     0481        494      .4830      274.1290      93.4779    21074.1290   5:51:  14.1290
     0482        495      .4860      274.6120      93.0758    21074.6120   5:51:  14.6120
     0483        496      .4850      275.0980      92.6880    21075.0980   5:51:  15.0980
     0484        492      .4810      275.5830      92.2808    21075.5830   5:51:  15.5830
     0485        496      .4850      276.0640      91.8847    21076.0640   5:51:  16.0640
     0486        497      .4820      276.5490      91.4812    21076.5490   5:51:  16.5490
     0487        496      .4850      277.0310      91.0779    21077.0310   5:51:  17.0310
     0488        494      .4830      277.5160      90.5699    21077.5160   5:51:  17.5160
     0489        498      .4870      277.9990      90.2614    21077.9990   5:51:  17.9990
     0490        494      .4830      278.4850      89.8481    21078.4850   5:51:  18.4850
     0491        492      .4820      278.9680      89.4372    21078.9680   5:51:  18.9680
     0492        498      .4870      279.4500      89.0210    21079.4500   5:51:  19.4500
     0493        494      .4830      279.9370      88.5003    21079.9370   5:51:  19.9370
     0494        492      .4810      280.4200      88.1808    21080.4200   5:51:  20.4200
     0495        494      .4840      280.9010      87.7609    21080.9010   5:51:  20.9010
     0496        494      .4870      281.3850      87.3361    21081.3850   5:51:  21.3850
    -0497        494      .4775      281.8680      86.9171    21081.8680   5:51:  21.8680
    -0498        494      .4835      282.3515      86.4814    21082.3515   5:51:  22.3515
     0499        496      .4850      282.8350      86.0595    21082.8350   5:51:  22.8350
     0500        498      .4870      283.3200      85.6161    21083.3200   5:51:  23.3200
     0501        492      .4820      283.8070      85.1776    21083.8070   5:51:  23.8070
     0502        496      .4850      284.2890      84.7415    21084.2890   5:51:  24.2890
     0503        494      .4830      284.7740      84.3024    21084.7740   5:51:  24.7740
     0504        498      .4880      285.2570      83.8590    21085.2570   5:51:  25.2570
     0505        494      .4830      285.7450      83.4103    21085.7450   5:51:  25.7450
     0506        494      .4830      286.2280      82.9649    21086.2280   5:51:  26.2280
     0507        496      .4840      286.7110      82.5169    21086.7110   5:51:  26.7110
     0508        494      .4830      287.1950      82.0657    21087.1950   5:51:  27.1950
     0509        494      .4830      287.6780      81.6103    21087.6780   5:51:  27.6780
     0510        493      .4840      288.1610      81.1587    21088.1610   5:51:  28.1610
    -0511        495      .4840      288.6450      80.7019    21088.6450   5:51:  28.6450
    -0512        493      .4840      289.1290      80.2410    21089.1290   5:51:  29.1290
     0513        494      .4840      289.6130      79.7709    21089.6130   5:51:  29.6130
     0514        494      .4830      290.0970      79.3165    21090.0970   5:51:  30.0970
     0515        494      .4830      290.5800      78.8444    21090.5800   5:51:  30.5800
     0516        494      .4830      291.0630      78.3842    21091.0630   5:51:  31.0630
     0517        494      .4840      291.5460      77.9112    21091.5460   5:51:  31.5460
    -0518        494      .4830      292.0300      77.4351    21092.0300   5:51:  32.0300
    -0519        496      .4830      292.5130      76.9617    21092.5130   5:51:  32.5130
     0520        494      .4840      292.9960      76.4912    21092.9960   5:51:  32.9960
     0521        494      .4840      293.4800      76.0074    21093.4800   5:51:  33.4800
    -0522        494      .4935      293.9630      75.5265    21093.9630   5:51:  33.9630
    -0523        494      .4835      294.4465      75.0429    21094.4465   5:51:  34.4465
     0524        494      .4830      294.9300      74.5571    21094.9300   5:51:  34.9300
     0525        494      .4830      295.4130      74.0695    21095.4130   5:51:  35.4130
     0526        493      .4840      295.8960      73.5718    21095.8960   5:51:  35.8960
     0527        492      .4810      296.3800      73.0880    21096.3800   5:51:  36.3800
     0528        496      .4850      296.8610      72.5929    21096.8610   5:51:  36.8610
     0529        497      .4820      297.3460      72.0995    21097.3460   5:51:  37.3460
    -0530        495      .4825      297.8280      71.5951    21097.8280   5:51:  37.8280
    -0531        495      .4825      298.3105      71.0939    21098.3105   5:51:  38.3105
    -0532        498      .4860      298.7930      70.5926    21098.7930   5:51:  38.7930
    -0533        498      .4860      299.2790      70.0864    21099.2790   5:51:  39.2790
     0534        492      .4810      299.7650      69.5790    21099.7650   5:51:  39.7650
     0535        494      .4840      300.2460      69.0717    21100.2460   5:51:  40.2460
     0536        494      .4870      300.7300      68.5580    21100.7300   5:51:  40.7300
     0537        456      .4830      301.2130      68.0469    21101.2130   5:51:  41.2130
     0538        494      .4840      301.6960      67.5232    21101.6960   5:51:  41.6960
     0539        494      .4830      302.1800      67.0009    21102.1800   5:51:  42.1800
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EXCEDE II  [illegible]  SPECTRAL  [illegible]  [illegible]                                05/07/80  13.37.41.          PAGE    8

  SPECTRAL S      LENGTH   LENGTH SEC    TIME A.L.     ALTITUDE     TIME U.T.    UT CLOCK TIME
       0540         494       .4830      302.6630      66.4805     21102.6630    5:51: 42.6630
       0541         494       .4840      303.1460      65.9630     21103.1460    5:51: 43.1460
       0542         495       .4840      303.6300      65.4470     21103.6300    5:51: 43.6300
       0543         496       .4810      304.1140      64.9113     21104.1140    5:51: 44.1140
       0544         494       .4820      304.5950      64.3849     21104.5950    5:51: 44.5950
       0545         494       .4820      305.0770      63.8557     21105.0770    5:51: 45.0770
       0546         494       .4910      305.5590      63.3272     21105.5590    5:51: 45.5590
       0547         494       .4820      306.0400      62.7887     21106.0400    5:51: 46.0400
       0548         494       .4820      306.5220      62.2509     21106.5220    5:51: 46.5220
       0549         494       .4810      307.0040      61.7129     21107.0040    5:51: 47.0040
       0550         494       .4820      307.4850      61.1729     21107.4850    5:51: 47.4850
       0551         494       .4810      307.9670      60.5265     21107.9670    5:51: 47.9670
       0552         494       .4820      308.4480      60.0801     21108.4480    5:51: 48.4480
       0553         494       .4820      308.9300      59.5314     21108.9300    5:51: 48.9300
       0554         494       .4810      309.4120      58.9875     21109.4120    5:51: 49.4120
       0555         494       .4820      309.8930      58.4366     21109.8930    5:51: 49.8930
       0556         494       .4820      310.3750      57.8813     21110.3750    5:51: 50.3750
       0557         492       .4790      310.8570      57.3229     21110.8570    5:51: 50.8570
       0558         494       .4820      311.3360      56.7718     21111.3360    5:51: 51.3360
       0559         494       .4820      311.8180      56.2100     21111.8180    5:51: 51.8180
       0560         494       .4810      312.3000      55.6470     21112.3000    5:51: 52.3000
       0561         494       .4820      312.7810      55.0830     21112.7810    5:51: 52.7810
       0562         494       .4820      313.2630      54.5157     21113.2630    5:51: 53.2630
       0563         494       .4810      313.7450      53.9462     21113.7450    5:51: 53.7450
       0564         494       .4820      314.2260      53.3757     21114.2260    5:51: 54.2260
       0565         492       .4800      314.7080      52.8018     21114.7080    5:51: 54.7080
       0566         494       .4810      315.1880      52.2281     21115.1880    5:51: 55.1880
       0567         495       .4840      315.6690      51.6551     21115.6690    5:51: 55.6690
       0568         492       .4800      316.1530      51.0683     21116.1530    5:51: 56.1530
       0569         496       .4830      316.6330      50.4891     21116.6330    5:51: 56.6330
      -0570         494       .4820      317.1160      49.9001     21117.1160    5:51: 57.1160
      -0571         496       .4820      317.5980      49.3102     21117.5980    5:51: 57.5980
      -0572         494       .4815      318.0800      48.7200     21118.0800    5:51: 58.0800
      -0573         494       .4815      318.5615      48.1333     21118.5615    5:51: 58.5615
       0574         494       .4810      319.0430      47.5415     21119.0430    5:51: 59.0430
       0575         494       .4820      319.5240      46.9480     21119.5240    5:51: 59.5240
       0576         494       .4820      320.0060      46.3511     21120.0060    5:52:   .0060
       0577         496       .4830      320.4880      45.7521     21120.4880    5:52:   .4880
       0578         502       .4900      320.9710      45.1466     21120.9710    5:52:   .9710
       0579         492       .4900      321.4610      44.5372     21121.4610    5:52:  1.4610
       0580         496       .4830      321.9410      43.9291     21121.9410    5:52:  1.9410
       0581         495       .4840      322.4240      43.3180     21122.4240    5:52:  2.4240
       0582         492       .4790      322.9080      42.7035     21122.9080    5:52:  2.9080
       0583         496       .4840      323.3870      42.0901     21123.3870    5:52:  3.3870
       0584         494       .4820      323.8710      41.4772     21123.8710    5:52:  3.8710
       0585         494       .4810      324.3530      40.8596     21124.3530    5:52:  4.3530
       0586         494       .4820      324.8340      40.2412     21124.8340    5:52:  4.8340
       0587         498       .4860      325.3160      39.6103     21125.3160    5:52:  5.3160
       0588         499       .4850      325.8020      38.9900     21125.8020    5:52:  5.8020
       0589         494       .4820      326.2870      38.3758     21126.2870    5:52:  6.2870
      -0590         494       .4815      326.7690      37.7374     21126.7690    5:52:  6.7690
      -0591         494       .4815      327.2505      37.1013     21127.2505    5:52:  7.2505
       0592         494       .4820      327.7320      36.4692     21127.7320    5:52:  7.7320
       0593         492       .4790      328.2140      35.8311     21128.2140    5:52:  8.2140
       0594         496       .4840      328.6930      35.2019     21128.6930    5:52:  8.6930
       0595         494       .4820      329.1770      34.5599     21129.1770    5:52:  9.1770
      -0596         497       .4845      329.6590      33.9173     21129.6590    5:52:  9.6590
      -0597         497       .4845      330.1435      33.2702     21130.1435    5:52: 10.1435
       0598         494       .4810      330.6280      32.5219     21130.6280    5:52: 10.6280
       0599         494       .4820      331.1090      31.9741     21131.1090    5:52: 11.1090
       0600         494       .4920      331.5910      31.3238     21131.5910    5:52: 11.5910
       0601         494       .4810      332.0730      30.6713     21132.0730    5:52: 12.0730
       0602         494       .4840      332.5540      30.0190     21132.5540    5:52: 12.5540
       0603         498       .4860      333.0380      29.3584     21133.0380    5:52: 13.0380
       0604         494       .4810      333.5240      28.6910     21133.5240    5:52: 13.5240
       0605         494       .4820      334.0050      28.0330     21134.0050    5:52: 14.0050
       0606         494       .4810      334.4870      27.3775     21134.4870    5:52: 14.4870
       0607         494       .4820      334.9680      26.7013     21134.9680    5:52: 14.9680
      -0608         497       .4845      335.4500      26.0315     21135.4500    5:52: 15.4500
      -0609         497       .4845      335.9345      25.3601     21135.9345    5:52: 15.9345
       0610         494       .4820      336.4190      24.6904     21136.4190    5:52: 16.4190
       0611         494       .4820      336.9010      24.0151     21136.9010    5:52: 16.9010
       0612         494       .4810      337.3830      23.3375     21137.3830    5:52: 17.3830
      -0613         495       .4825      337.8640      22.6602     21137.8640    5:52: 17.8640
      -0614         495       .4825      338.3465      21.9776     21138.3465    5:52: 18.3465
       0615         502       .4900      338.8300      21.2928     21138.8300    5:52: 18.8300
       0616         494       .4820      339.3120      20.5951     21139.3120    5:52: 19.3120
```

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EXCEDE II  NS-6  SPECTRAL SWEEP STARTS                                          05/02/80  13.37.41.         PAGE    9
      SPECTRAL S        LENGTH   LENGTH SEC    TIME A.L.     ALTITUDE     TIME U.T.    UT CLOCK TIME
            5617           496        .4930     339.8010      19.9116    21139.8010    5:52: 19.8010
            5618           494        .4820     340.2840      19.2205    21140.2840    5:52: 20.2840
            5619           494        .4810     340.7660      18.5237    21140.7660    5:52: 20.7660
```

APPENDIX B

Spectral Scan Start Times and Other Data for HS-3B-1 CVF

Data in this appendix is defined as follows:

Column	Title	Definition
1	Scan Number	Number assigned to the spectral scan
2	Length	Number of data points in spectral scan
3	Length sec	Duration of the spectral scan in seconds
4	Time A-L	Time after launch in seconds of scan start
5	Altitude	Payload altitude corresponding to T.A.L.
6	Time U.T.	T.A.L. in U.T. seconds
7	Clock Time U.T.	T.A.L. in clock form

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EXCEDE II  IC-3  SPECTRAL SWEEP STARTS                                        06/06/80  17.32.13.          PAGE    1

   SPECTRAL #      LENGTH   LENGTH SEC     TIME A.L.      ALTITUDE       TIME U.T.    UT CLOCK TIME
       1001         1234       1.2080        40.6480       26.2331      20840.6480    5:47: 20.6480
       1002         1232       1.2060        41.8560       28.5953      20841.8560    5:47: 21.8560
       1003         1232       1.2060        43.0620       30.2410      20843.0620    5:47: 23.0620
       1004         1234       1.2080        44.2680       31.8731      20844.2680    5:47: 24.2680
       1005         1232       1.2070        45.4760       33.4942      20845.4760    5:47: 25.4760
       1006         1232       1.2060        46.6830       35.1007      20846.6830    5:47: 26.6830
       1007         1234       1.2080        47.8890       36.6913      20847.8890    5:47: 27.8890
       1008         1232       1.2060        49.0970       38.2713      20849.0970    5:47: 29.0970
       1009         1232       1.2060        50.3030       39.8351      20850.3030    5:47: 30.3030
       1010         1232       1.2070        51.5090       41.3851      20851.5090    5:47: 31.5090
       1011         1234       1.2080        52.7160       42.9228      20852.7160    5:47: 32.7160
       1012         1232       1.2060        53.9240       44.4493      20853.9240    5:47: 33.9240
       1013         1232       1.2060        55.1300       45.9570      20855.1300    5:47: 35.1300
       1014         1234       1.2080        56.3360       47.4524      20856.3360    5:47: 36.3360
       1015         1232       1.2070        57.5440       48.9356      20857.5440    5:47: 37.5440
       1016         1232       1.2060        58.7510       50.4058      20858.7510    5:47: 38.7510
       1017         1234       1.2080        59.9570       51.8601      20859.9570    5:47: 39.9570
       1018         1232       1.2060        61.1650       53.3037      20861.1650    5:47: 41.1650
       1019         1232       1.2060        62.3710       54.7302      20862.3710    5:47: 42.3710
       1020         1234       1.2080        63.5770       56.1435      20863.5770    5:47: 43.5770
       1021         1232       1.2070        64.7850       57.5455      20864.7850    5:47: 44.7850
       1022         1232       1.2060        65.9920       58.9327      20865.9920    5:47: 45.9920
       1023         1234       1.2080        67.1980       60.3070      20867.1980    5:47: 47.1980
       1024         1232       1.2060        68.4060       61.6659      20868.4060    5:47: 48.4060
       1025         1234       1.2080        69.6120       63.0108      20869.6120    5:47: 49.6120
       1026         1232       1.2060        70.8200       64.3443      20870.8200    5:47: 50.8200
       1027         1234       1.2080        72.0260       65.6619      20872.0260    5:47: 52.0260
       1028         1232       1.2060        73.2340       66.9697      20873.2340    5:47: 53.2340
       1029         1232       1.2060        74.4400       68.2593      20874.4400    5:47: 54.4400
       1030         1234       1.2090        75.6460       69.5349      20875.6460    5:47: 55.6460
       1031         1232       1.2060        76.8540       70.7999      20876.8540    5:47: 56.8540
       1032         1234       1.2090        78.0600       72.0432      20878.0600    5:47: 58.0600
       1033         1232       1.2060        79.2690       73.2878      20879.2690    5:47: 59.2690
       1034         1234       1.2080        80.4750       74.5037      20880.4750    5:48:   .4750
       1035         1232       1.2060        81.6830       75.7200      20881.6830    5:48:  1.6830
       1036         1232       1.2060        82.8890       76.9145      20882.8890    5:48:  2.8890
       1037         1234       1.2080        84.0950       78.0954      20884.0950    5:48:  4.0950
       1038         1232       1.2060        85.3030       79.2645      20885.3030    5:48:  5.3030
       1039         1234       1.2080        86.5090       80.4191      20886.5090    5:48:  6.5090
       1040         1232       1.2060        87.7170       81.5529      20887.7170    5:48:  7.7170
       1041         1234       1.2080        88.9230       82.6850      20888.9230    5:48:  8.9230
       1042         1232       1.2060        90.1310       83.8014      20890.1310    5:48: 10.1310
       1043         1234       1.2080        91.3370       84.8932      20891.3370    5:48: 11.3370
       1044         1232       1.2060        92.5450       85.9852      20892.5450    5:48: 12.5450
       1045         1232       1.2060        93.7510       87.0577      20893.7510    5:48: 13.7510
       1046         1234       1.2080        94.9570       88.1155      20894.9570    5:48: 14.9570
       1047         1234       1.2080        96.1650       89.1616      20896.1650    5:48: 16.1650
       1048         1232       1.2060        97.3730       90.1935      20897.3730    5:48: 17.3730
       1049         1232       1.2060        98.5790       91.2103      20898.5790    5:48: 18.5790
       1050         1234       1.2080        99.7850       92.2135      20899.7850    5:48: 19.7850
       1051         1232       1.2060       100.9930       93.2046      20900.9930    5:48: 20.9930
       1052         1234       1.2080       102.1990       94.1803      20902.1990    5:48: 22.1990
       1053         1232       1.2050       103.4070       95.1469      20903.4070    5:48: 23.4070
       1054         1234       1.2080       104.6120       96.0917      20904.6120    5:48: 24.6120
       1055         1232       1.2060       105.8200       97.0290      20905.8200    5:48: 25.8200
       1056         1234       1.2080       107.0260       97.9431      20907.0260    5:48: 27.0260
       1057         1232       1.2060       108.2340       98.8589      20908.2340    5:48: 28.2340
       1058         1234       1.2080       109.4400       99.7518      20909.4400    5:48: 29.4400
       1059         1232       1.2060       110.6480      100.6333      20910.6480    5:48: 30.6480
       1060         1232       1.2060       111.8540      101.4937      20911.8540    5:48: 31.8540
       1061         1234       1.2080       113.0600      102.3326      20913.0600    5:48: 33.0600
       1062         1232       1.2050       114.2680      103.1529      20914.2680    5:48: 34.2680
       1063         1234       1.2080       115.4730      104.0176      20915.4730    5:48: 35.4730
       1064         1232       1.2060       116.6810      104.8302      20916.6810    5:48: 36.6810
       1065         1234       1.2080       117.8870      105.6297      20917.8870    5:48: 37.8870
       1066         1232       1.2060       119.0950      106.4166      20919.0950    5:48: 39.0950
       1067         1234       1.2080       120.3010      107.1851      20920.3010    5:48: 40.3010
       1068         1232       1.2060       121.5090      107.9426      20921.5090    5:48: 41.5090
       1069         1232       1.2070       122.7150      108.6852      20922.7150    5:48: 42.7150
       1070         1232       1.2060       123.9220      109.4170      20923.9220    5:48: 43.9220
       1071         1234       1.2080       125.1280      110.1330      20925.1280    5:48: 45.1280
       1072         1232       1.2060       126.3360      110.8366      20926.3360    5:48: 46.3360
       1073         1234       1.2080       127.5420      111.5251      20927.5420    5:48: 47.5420
       1074         1232       1.2060       128.7500      112.2017      20928.7500    5:48: 48.7500
       1075         1234       1.2070       129.9560      [illegible]   20929.9560    5:48: 49.9560
       1076         1232       1.2060       131.1630      113.5294      20931.1630    5:48: 51.1630
       1077         1234       [illegible]  132.3690      114.16[illegible] [illegible] 5:48: 52.3690
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EXCEDE II  HS-2  SPECTRAL SWEEP STARTS                                            06/06/80  17.32.13.            PAGE    2

     SPECTRUM #      LENGTH  LENGTH SEC     TIME A.L.     ALTITUD       TIME U.T.    UT CLOCK TIME
        1078          1232     1.2060       133.5770     114.7061      20933.5770    5:48: 53.5770
        1079          1234     1.2070       134.7830     115.3723      20934.7830    5:48: 54.7830
        1080          1232     1.2060       135.9900     115.9662      20935.9900    5:48: 55.9900
        1081          1232     1.2060       137.1960     116.5455      20937.1960    5:48: 57.1960
        1082          1234     1.2080       138.4020     117.1111      20938.4020    5:48: 58.4020
        1083          1232     1.2060       139.6100     117.6640      20939.6100    5:48: 59.6100
        1084          1234     1.2070       140.8160     118.2023      20940.8160    5:49:   .8160
        1085          1232     1.2060       142.0230     118.7271      20942.0230    5:49:  2.0230
        1086          1234     1.2080       143.2290     119.2393      20943.2290    5:49:  3.2290
        1087          1232     1.2060       144.4370     119.7359      20944.4370    5:49:  4.4370
        1088          1234     1.2070       145.6430     120.2209      20945.6430    5:49:  5.6430
        1089          1232     1.2060       146.8500     120.6907      20946.8500    5:49:  6.8500
        1090          1234     1.2080       148.0560     121.1466      20948.0560    5:49:  8.0560
        1091          1232     1.2060       149.2640     121.5899      20949.2640    5:49:  9.2640
        1092          1234     1.2070       150.4700     122.0198      20950.4700    5:49: 10.4700
        1093          1232     1.2060       151.6770     122.4344      20951.6770    5:49: 11.6770
        1094          1234     1.2080       152.8830     122.8360      20952.8830    5:49: 12.8830
        1095          1232     1.2050       154.0910     123.2246      20954.0910    5:49: 14.0910
        1096          1234     1.2200       155.2960     123.5994      20955.2960    5:49: 15.2960
        1097          1232     1.2320       156.5160     123.9631      20956.5160    5:49: 16.5160
        1098          1234     1.2340       157.7480     124.3172      20957.7480    5:49: 17.7480
        1099          1232     1.2320       158.9820     124.6576      20958.9820    5:49: 18.9820
        1100          1234     1.2340       160.2140     124.9831      20960.2140    5:49: 20.2140
        1101          1232     1.2320       161.4480     125.2963      20961.4480    5:49: 21.4480
        1102          1234     1.2340       162.6800     125.5913      20962.6800    5:49: 22.6800
        1103          1232     1.2320       163.9140     125.8752      20963.9140    5:49: 23.9140
        1104          1232     1.2320       165.1460     126.1435      20965.1460    5:49: 25.1460
        1105          1234     1.2340       166.3780     126.3977      20966.3780    5:49: 26.3780
        1106          1234     1.2340       167.6120     126.6390      20967.6120    5:49: 27.6120
        1107          1232     1.2320       168.8460     126.8540      20968.8460    5:49: 28.8460
        1108          1234     1.2340       170.0780     127.0754      20970.0780    5:49: 30.0780
        1109          1232     1.2320       171.3120     127.2728      20971.3120    5:49: 31.3120
        1110          1232     1.2320       172.5440     127.4556      20972.5440    5:49: 32.5440
        1111          1234     1.2340       173.7760     127.6242      20973.7760    5:49: 33.7760
        1112          1232     1.2320       175.0100     127.7788      20975.0100    5:49: 35.0100
        1113          1234     1.2340       176.2420     127.9183      20976.2420    5:49: 36.2420
        1114          1232     1.2320       177.4760     128.0449      20977.4760    5:49: 37.4760
        1115          1234     1.2340       178.7080     128.1553      20978.7080    5:49: 38.7080
        1116          1232     1.2320       179.9420     128.2537      20979.9420    5:49: 39.9420
        1117          1234     1.2340       181.1740     128.3366      20981.1740    5:49: 41.1740
        1118          1232     1.2320       182.4080     128.4054      20982.4080    5:49: 42.4080
        1119          1234     1.2340       183.6400     128.4598      20983.6400    5:49: 43.6400
        1120          1232     1.2320       184.8740     128.5001      20984.8740    5:49: 44.8740
        1121          1234     1.2340       186.1060     128.5257      20986.1060    5:49: 46.1060
        1122          1232     1.2320       187.3400     128.5376      20987.3400    5:49: 47.3400
        1123          1234     1.2340       188.5720     128.5349      20988.5720    5:49: 48.5720
        1124          1232     1.2320       189.8060     128.5179      20989.8060    5:49: 49.8060
        1125          1234     1.2340       191.0380     128.4867      20991.0380    5:49: 51.0380
        1126          1232     1.2320       192.2720     128.4412      20992.2720    5:49: 52.2720
        1127          1234     1.2340       193.5040     128.3815      20993.5040    5:49: 53.5040
        1128          1232     1.2320       194.7380     128.3073      20994.7380    5:49: 54.7380
        1129          1234     1.2340       195.9700     128.2130      20995.9700    5:49: 55.9700
        1130          1232     1.2320       197.2040     128.1153      20997.2040    5:49: 57.2040
        1131          1234     1.2340       198.4360     127.9995      20998.4360    5:49: 58.4360
        1132          1232     1.2320       199.6700     127.8682      20999.6700    5:49: 59.6700
        1133          1234     1.2340       200.9020     127.7228      21000.9020    5:50:   .9020
        1134          1232     1.2320       202.1360     127.5629      21002.1360    5:50:  2.1360
        1135          1234     1.2340       203.3680     127.3890      21003.3680    5:50:  3.3680
        1136          1232     1.2320       204.6020     127.2016      21004.6020    5:50:  4.6020
        1137          1234     1.2340       205.8340     126.9981      21005.8340    5:50:  5.8340
        1138          1232     1.2320       207.0680     126.7811      21007.0680    5:50:  7.0680
        1139          1234     1.2340       208.3000     126.5501      21008.3000    5:50:  8.3000
        1140          1232     1.2320       209.5340     126.3044      21009.5340    5:50:  9.5340
        1141          1234     1.2340       210.7660     126.0469      21010.7660    5:50: 10.7660
        1142          1232     1.2320       212.0000     125.7707      21012.0000    5:50: 12.0000
        1143          1234     1.2340       213.2320     125.4826      21013.2320    5:50: 13.2320
        1144          1232     1.2320       214.4660     125.1739      21014.4660    5:50: 14.4660
        1145          1234     1.2340       215.6980     124.8672      21015.6980    5:50: 15.6980
        1146          1232     1.2320       216.9320     124.5313      21016.9320    5:50: 16.9320
        1147          1234     1.2340       218.1640     124.1860      21018.1640    5:50: 18.1640
        1148          1232     1.2320       219.3980     123.8266      21019.3980    5:50: 19.3980
        1149          1234     1.2340       220.6300     [illegible]   21020.6300    5:50: 20.6300
        1150          1232     1.2320       221.8640     [illegible]   21021.8640    5:50: 21.8640
        1151          1234     1.2340       223.0960     [illegible]   21023.0960    5:50: 23.0960
        1152          1232     1.2320       224.3300     122.2459      21024.3300    5:50: 24.3300
        1153          1232     1.2320       225.5620     [illegible]   21025.5620    5:50: 25.5620
        1154          1234     [illegible]  226.7940     [illegible]   21026.7940    5:50: 26.7940
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EXCEDE II  45-7  SPECTRAL SWEEP STARTS                                               05/06/80  17.32.17.          PAGE

  SPECTRAL #     LENGTH   LENGTH SEC    TIME A.L.    ALTITUDE    TIME U.T.    UT CLOCK TIME
     1155         1234      1.2340      228.0280     120.9042   21028.0280    5:50: 28.0280
     1156         1232      1.2320      229.2620     120.4749   21029.2620    5:50: 29.2620
     1157         1234      1.2340      230.4960     119.9470   21030.4960    5:50: 30.4960
     1158         1232      1.2320      231.7280     119.4440   21031.7280    5:50: 31.7280
     1159         1234      1.2340      232.9600     118.9277   21032.9600    5:50: 32.9600
     1160         1232      1.2320      234.1940     118.3961   21034.1940    5:50: 34.1940
     1161         1234      1.2340      235.4260     117.8510   21035.4260    5:50: 35.4260
    -1162          945       .9450      236.6600     117.2911   21036.6600    5:50: 36.6600
    -1163          945       .9450      237.6050     116.8525   21037.6050    5:50: 37.6050
     1164         1232      1.2060      238.5500     116.4055   21038.5500    5:50: 38.5500
     1165         1234      1.2070      239.7560     115.8229   21039.7560    5:50: 39.7560
     1166         1234      1.2080      240.9630     115.2251   21040.9630    5:50: 40.9630
     1167         1232      1.2050      242.1710     114.6151   21042.1710    5:50: 42.1710
     1168         1234      1.2080      243.3760     113.9920   21043.3760    5:50: 43.3760
     1169         1232      1.2050      244.5840     113.3576   21044.5840    5:50: 44.5840
     1170         1232      1.2060      245.7890     112.7032   21045.7890    5:50: 45.7890
     1171         1234      1.2070      246.9950     112.0396   21046.9950    5:50: 46.9950
     1172         1232      1.2050      248.2020     111.3537   21048.2020    5:50: 48.2020
     1173         1234      1.2080      249.4070     110.6683   21049.4070    5:50: 49.4070
     1174         1234      1.2070      250.6150     109.9615   21050.6150    5:50: 50.6150
     1175         1232      1.2060      251.8220     109.2416   21051.8220    5:50: 51.8220
     1176         1234      1.2070      253.0280     108.5096   21053.0280    5:50: 53.0280
     1177         1232      1.2060      254.2350     107.7613   21054.2350    5:50: 54.2350
     1178         1234      1.2070      255.4410     107.0010   21055.4410    5:50: 55.4410
     1179         1232      1.2060      256.6480     106.2264   21056.6480    5:50: 56.6480
     1180         1232      1.2050      257.8540     105.4347   21057.8540    5:50: 57.8540
     1181         1234      1.2070      259.0590     104.6381   21059.0590    5:50: 59.0590
     1182         1232      1.2060      260.2660     103.8224   21060.2660    5:51:   .2660
     1183         1234      1.2070      261.4720     102.9938   21061.4720    5:51:  1.4720
     1184         1232      1.2060      262.6790     102.1507   21062.6790    5:51:  2.6790
     1185         1234      1.2070      263.8850     101.2947   21063.8850    5:51:  3.8850
     1186         1234      1.2070      265.0920     100.4244   21065.0920    5:51:  5.0920
     1187         1232      1.2060      266.2990      99.5403   21066.2990    5:51:  6.2990
     1188         1232      1.2050      267.5050      98.6437   21067.5050    5:51:  7.5050
     1189         1234      1.2080      268.7100      97.7314   21068.7100    5:51:  8.7100
     1190         1232      1.2050      269.9180      96.8076   21069.9180    5:51:  9.9180
     1191         1234      1.2080      271.1230      95.8703   21071.1230    5:51: 11.1230
     1192         1232      1.2050      272.3310      94.9171   21072.3310    5:51: 12.3310
     1193         1234      1.2070      273.5360      93.9526   21073.5360    5:51: 13.5360
     1194         1232      1.2060      274.7430      92.9729   21074.7430    5:51: 14.7430
     1195         1234      1.2070      275.9490      91.9801   21075.9490    5:51: 15.9490
     1196         1232      1.2060      277.1560      90.9729   21077.1560    5:51: 17.1560
     1197         1234      1.2070      278.3620      89.9529   21078.3620    5:51: 18.3620
     1198         1234      1.2070      279.5690      88.9194   21079.5690    5:51: 19.5690
     1199         1232      1.2060      280.7760      87.8702   21080.7760    5:51: 20.7760
     1200         1232      1.2050      281.9820      86.8032   21081.9820    5:51: 21.9820
     1201         1234      1.2070      283.1870      85.7354   21083.1870    5:51: 23.1870
     1202         1232      1.2060      284.3940      84.6462   21084.3940    5:51: 24.3940
     1203         1234      1.2070      285.6000      83.5442   21085.6000    5:51: 25.6000
     1204         1232      1.2060      286.8070      82.4276   21086.8070    5:51: 26.8070
     1205         1234      1.2070      288.0130      81.2987   21088.0130    5:51: 28.0130
     1206         1234      1.2070      289.2200      80.1593   21089.2200    5:51: 29.2200
     1207         1232      1.2060      290.4270      78.9957   21090.4270    5:51: 30.4270
     1208         1232      1.2050      291.6330      77.9257   21091.6330    5:51: 31.6330
     1209         1234      1.2070      292.8380      76.6433   21092.8380    5:51: 32.8380
     1210         1232      1.2060      294.0450      75.4446   21094.0450    5:51: 34.0450
     1211         1234      1.2070      295.2510      74.2333   21095.2510    5:51: 35.2510
     1212         1232      1.2050      296.4580      73.0073   21096.4580    5:51: 36.4580
     1213         1188      1.1980      297.6630      71.7636   21097.6630    5:51: 37.6630
     1214         1144      1.2140      298.8610      70.5257   21098.8610    5:51: 38.8610
     1215         1255      1.2530      300.0750      69.2503   21100.0750    5:51: 40.0750
    -1216         1207      1.1845      301.3280      67.9215   21101.3280    5:51: 41.3280
    -1217         1203      1.1845      302.5125      66.6593   21102.5125    5:51: 42.5125
     1218         1234      1.2040      303.6970      65.3670   21103.6970    5:51: 43.6970
     1219         1232      1.2020      304.9010      64.0485   21104.9010    5:51: 44.9010
     1220         1232      1.2010      306.1030      62.7197   21106.1030    5:51: 46.1030
     1221         1234      1.2030      307.3040      61.3763   21107.3040    5:51: 47.3040
     1222         1232      1.2010      308.5070      60.0192   21108.5070    5:51: 48.5070
     1223         1234      1.2030      309.7080      58.6497   21109.7080    5:51: 49.7080
     1224         1232      1.2020      310.9110      57.2674   21110.9110    5:51: 50.9110
     1225         1234      1.2030      312.1130      55.8657   21112.1130    5:51: 52.1130
     1226         1232      1.2010      313.3160      54.4537   21113.3160    5:51: 53.3160
     1227         1234      1.2030      314.5170      53.0235   21114.5170    5:51: 54.5170
     1228         1232      1.2010      315.7200      51.5812   21115.7200    5:51: 55.7200
     1229         1234      1.2030      316.9210      50.1310   21116.9210    5:51: 56.9210
     1230         1232      1.2020      318.1240      48.672    21118.1240    5:51: 58.1240
     1231         1234      1.20        319.3260      47.1      21119.3260    5:51: 59.3260
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 EXCEDE II  HS-3  SPECTRAL SWEEP STARTS                                        06/06/80  17.37.13.          PAGE    4
     SPECTRAL #        LENGTH   LENGTH SEC     TIME A.L.     ALTITUDE     TIME U.T.   UT CLOCK TIME
         1232            1232       1.2010      320.5290      45.6490    21120.5290   5:52:    .5290
         1233            1234       1.2030      321.7300      44.1939    21121.7300   5:52:   1.7300
         1234            1232       1.2010      322.9330      42.6727    21122.9330   5:52:   2.9330
         1235            1234       1.2030      324.1340      41.1405    21124.1340   5:52:   4.1340
         1236            1232       1.2020      325.3370      39.5922    21125.3370   5:52:   5.3370
         1237            1234       1.2030      326.5390      38.0315    21126.5390   5:52:   6.5390
         1238            1232       1.2010      327.7420      36.4559    21127.7420   5:52:   7.7420
         1239            1234       1.2030      328.9430      34.8635    21128.9430   5:52:   8.9430
         1240            1232       1.2010      330.1460      33.2569    21130.1460   5:52:  10.1460
         1241            1236       1.2030      331.3470      31.5533    21131.3470   5:52:  11.3470
         1242            1232       1.2020      332.5500      30.0234    21132.5500   5:52:  12.5500
         1243            1234       1.2030      333.7520      28.3813    21133.7520   5:52:  13.7520
         1244            1228       1.1980      334.9550      26.7243    21134.9550   5:52:  14.9550
         1245            1238       1.2060      336.1530      25.0605    21136.1530   5:52:  16.1530
         1246            1234       1.2030      337.3590      23.3723    21137.3590   5:52:  17.3590
         1247            1232       1.2020      338.5620      21.6745    21138.5620   5:52:  18.5620
```

APPENDIX C

Chopper Reference Phase Angle and Other Data for HS-3B-1 CVF

Constants A, b, and c are defined by Equation 3-12 of the text. The frequency (FREQ) is the best fit chopper frequency and THETA is the chopper phase angle θ_c relative to the scan start. MEAN HI and LO are the spectral mean counts for the high and low gain. NPTS is the number of points of the scan. CHISQ and INTER are the goodness of fit parameter and the number of interations required to fit the data.

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   EXCEDE II     HS-3 CVF    BASE1 ANALYSIS                                                               0[illegible]/16/80  16.21.37.
SCAN           NPTS     FREQ         A          B          C          THETA     MEAN(HI)    MEAN(LO)     CHISQR ITER
 1001           617   106.671    238.151    162.181    174.395     47.078    524.607    525.828   1047.930   10
 1002           616   106.648    251.122   -219.178   -122.570    209.215    513.570    525.927   1102.378   11
 1003           616   106.652    240.653    -18.194    239.965     94.336    514.011    525.928    769.904    9
 1004           617   106.645    250.134    237.090    -79.719    341.415    514.051    525.930    876.766    2
 1005           616   106.643    243.882   -220.060    105.088    154.476    514.075    525.926    780.963    7
 1006           616   106.640    247.644    175.153    175.068     44.936    514.024    525.926    826.592   11
 1007           617   106.639    246.072    108.289   -220.964    296.108    514.115    525.882    806.324    3
 1008           616   106.642    245.971   -101.136    224.107    114.289    533.063    525.864    796.511   10
 1009           616   106.633    247.547    246.618     21.429      4.966    524.999    525.839    814.065    6
 1010           616   106.639    244.996    -47.475   -240.352    258.827    513.685    525.918    781.522    2
 1011           617   106.638    248.024   -218.611    117.154    151.813    514.042    525.909    821.830    7
 1012           616   106.639    245.170    212.487   -122.301    330.077    514.129    525.920    778.611    7
 1013           616   106.638    247.274   -179.463   -170.089    223.461    514.127    525.910    814.752   10
 1014           617   106.637    246.012   -110.526    219.787    116.697    514.201    525.876    790.759   10
 1015           616   106.632    246.939    103.079   -224.395    294.672    534.798    525.858    805.303    2
 1016           616   106.636    246.324   -243.006    -40.294    189.415    525.314    525.839    801.347    9
 1017           617   106.632    246.370     30.563    244.466     82.874    513.743    525.941    797.921    6
 1018           616   106.632    246.621    -32.418   -244.481    262.447    514.157    525.923    791.314    2
 1019           616   106.634    246.114   -227.500     93.892    157.573    514.300    525.935    793.342    7
 1020           617   106.630    246.770    153.800    192.979     51.446    514.246    525.951    802.694   12
 1021           616   106.634    246.169   -149.555   -195.531    232.589    514.278    525.951    791.994    9
 1022           616   106.633    246.701   -150.981    195.106    127.734    514.369    525.916    801.434   10
 1023           617   106.628    246.281    228.188     92.653     22.099    535.318    525.894    797.609    9
 1024           616   106.633    246.424   -225.182   -100.090    203.965    526.405    525.849    800.505   10
 1025           617   106.632    246.709    -40.804    242.906     99.536    513.860    525.948    792.091    9
 1026           616   106.627    245.663     41.130   -243.210    279.599    514.293    525.946    803.046    5
 1027           617   106.631    246.523   -246.122     14.043    176.734    514.327    525.961    794.208    8
 1028           616   106.628    245.582    246.370    -10.222    357.624    514.326    525.968    804.105    2
 1029           616   106.630    246.703    -64.807   -238.079    254.770    514.403    525.965    798.971    2
 1030           617   106.630    246.484   -216.135    118.491    151.267    514.409    525.954    802.209    8
 1031           616   106.629    245.613    220.010   -109.186    333.606    535.220    525.938    798.889    8
 1032           617   106.627    247.795   -152.288   -195.476    232.079    526.034    525.920    832.461    8
 1033           616   106.623    244.678    145.358    196.821     53.553    513.880    525.968    783.956   11
 1034           617   106.624    242.362    162.152   -180.127    311.994    514.220    525.954   3322.483    2
 1035           616   106.602    247.576   -153.334    193.902    128.445    514.413    525.933   1671.623   11
 1036           616   106.620    241.767    206.418    125.868     31.374    514.378    525.923    890.842   10
 1037           617   106.617    249.043     85.567   -233.882    290.095    602.987    608.768   1047.049    6
 1038           616   106.632    241.042   -107.289    216.853    116.324    510.225    525.867   1098.336    2
 1039           617   106.619    252.546    244.939     61.514     14.098    510.128    525.857    949.943    9
 1040           616   106.625    242.673   -228.714    -81.116    199.528    693.759    686.599    790.263   10
 1041           617   106.622    249.346    -44.833    245.791    100.337    654.182    628.842    851.765    8
 1042           616   106.616    244.746     59.033   -237.520    283.957    505.766    525.730    793.256    4
 1043           617   106.622    247.603   -245.674    -30.844    187.156    509.026    525.855    830.160    8
 1044           616   106.613    247.107    242.346     48.275     11.266    508.730    525.864    817.671    7
 1045           616   106.617    245.327     16.032   -245.303    273.739    509.373    525.859    807.746    6
 1046           617   106.618    247.355   -247.110     19.207    175.556    510.075    525.844    822.735    7
 1047           617   106.615    245.073    245.863      7.347      1.712    510.741    525.837    800.445    2
 1048           616   106.618    247.701   -244.164    -41.704    189.693    509.933    525.853    818.214    9
 1049           616   106.618    246.335     -9.245    245.151     92.151    511.472    525.877    796.360    5
 1050           617   106.618    247.036    245.971    -23.338    354.579    511.908    525.864    809.672    3
 1051           616   106.617    246.307   -246.649     -8.846    182.054    511.707    525.875    800.193    9
 1052           617   106.611    246.879     26.878    245.412     83.750    512.677    525.840    803.627    6
 1053           616   106.612    246.014      7.916   -246.687    271.838    512.784    525.825    795.770    6
 1054           617   106.616    246.345   -246.333     17.371    175.966    512.929    525.781    794.352    8
 1055           616   106.611    246.013    246.517     13.972      3.244    513.127    525.787    799.182    5
 1056           617   106.611    247.041    -13.573   -246.667    266.851    513.224    525.810    802.110    4
 1057           616   106.614    247.145    -27.537    245.606     96.397    508.623    524.922    800.227    8
 1058           617   106.611    246.643    246.642      -.260    350.940    786.639    745.519    794.389    2
 1059           616   106.612    246.741   -243.190    -41.706    189.731    677.701    647.054    808.439    9
 1060           616   106.609    247.437    -15.064    247.479     93.483    502.558    525.577    810.588    4
 1061           617   106.611    245.933    245.861     -5.916    358.622    512.186    525.667    795.059    2
 1062           616   106.611    247.610   -244.744    -37.565    188.726    513.815    525.672    816.762    9
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    EXCEDE II     HS-3 CVF    PASS1 ANALYSIS                                                              09/16/80  17.44.35.
SCAN          NPTS     FREQ          A           B            C          THETA     MEAN(HI)    MEAN(LO)    CHISQR ITER
 1063          617   106.610     246.693     -13.928     246.299       93.236     513.330     525.682     791.674    4
 1064          616   106.606     246.164      55.296    -240.694      282.938     513.925     525.664     803.696    5
 1065          617   106.610     247.010    -243.758     -39.950      189.308     513.398     525.662     803.805    9
 1066          616   106.606     247.124     233.406      81.190       19.180     513.913     525.627     797.189    9
 1067          617   106.608     246.348      65.461    -239.010      285.378     513.651     525.621     797.605    2
 1068          616   106.608     246.990    -110.626     220.830      116.609     514.024     525.604     799.105   10
 1069          617   106.604     247.242     229.514      91.935       21.829     513.899     525.600     801.291   10
 1070          616   106.608     246.720    -204.322    -138.288      214.091     513.913     525.562     797.726   10
 1071          617   106.608     247.568    -125.349     213.195      120.553     513.940     525.560     804.961    9
 1072          616   106.608     246.626     155.595    -182.764      312.178     514.129     525.542     792.201    5
 1073          617   106.607     247.407    -192.367    -155.579      218.965     513.842     525.544     810.673    9
 1074          616   106.601     246.827     159.418     188.439       49.769     519.239     525.523     799.342   11
 1075          617   106.608     246.807     184.344    -164.106      318.324     518.190     525.472     800.582    7
 1076          616   106.607     247.309    -215.135     121.979      150.447     563.595     537.631     805.350    7
 1077          617   106.602     246.862     135.435     206.393       56.727     508.589     525.369     809.860   11
 1078          616   106.606     247.245     -83.879    -232.582      250.168     515.673     525.348     806.714    4
 1079          617   106.604     247.313    -228.616      94.331      157.578     550.438     529.647     801.150    7
 1080          616   106.605     246.573     243.238     -40.453      350.557     508.244     525.321     796.785    5
 1081          616   106.599     247.480     -54.831    -241.329      257.200     545.411     525.683     810.878    5
 1082          617   106.604     246.788    -240.025      57.381      166.555     510.673     525.304     791.275    8
 1083          616   106.601     247.760     247.748      -2.506      359.420     513.495     525.316     811.413    2
 1084          617   106.598     246.269     -12.404    -245.956      267.113     515.372     525.310     792.639    2
 1085          616   106.601     248.312     -49.589     243.290      101.543     526.601     525.350     818.420   10
 1086          617   106.597     246.081     242.912      39.362        9.204     516.665     525.293     784.992    6
 1087          616   106.603     247.635    -224.920    -103.749      204.762     523.769     525.312     809.557   10
 1088          617   106.591     246.422     -37.774     225.631      113.336     523.959     525.300     799.998   10
 1089          616   106.603     246.569     153.013    -193.347      308.358     512.019     525.308     811.115    5
 1090          617   106.600     247.732    -137.836    -149.104      217.005     512.929     525.320     817.135   10
 1091          616   106.596     246.645     156.088     190.973       50.740     512.910     525.310     800.272   11
 1092          617   106.600     248.010     193.792    -154.769      321.388     513.839     525.323     815.460    7
 1093          616   106.600     246.240    -225.433      99.065      156.277     513.467     525.278     789.880    7
 1094          617   106.595     247.397     114.809     224.651       64.989     513.838     525.289     819.084   11
 1095          616   106.596     245.460     -40.885    -243.045      260.451     513.795     525.328     795.381    2
 1096          617   106.598     247.971    -244.994      37.656      171.262     513.759     525.301     805.967    8
 1097          616   106.593     246.816     245.701      23.437        5.449     513.646     525.236     795.139    4
 1098          617   106.594     247.346      26.963    -245.870      276.263     513.693     525.193     803.891    5
 1099          616   106.597     247.368     -95.497     228.191      112.709     513.730     525.260     801.440   10
 1100          617   106.593     246.900     227.827      94.895       22.613     513.682     525.285     801.029    9
 1101          616   106.597     247.520    -130.825    -157.646      219.561     513.556     525.191     810.114   10
 1102          617   106.599     246.717    -151.243     186.735      130.810     513.652     525.171     798.591    9
 1103          616   106.596     248.127     207.573    -135.942      326.779     513.656     525.157     817.911    7
 1104          616   106.597     246.627    -130.171    -209.477      238.143     513.681     525.177     790.899    8
 1105          617   106.596     247.717    -213.458     125.696      149.508     513.647     525.130     812.406    8
 1106          617   106.596     246.877     239.701     -59.092      346.151     513.605     525.145     804.029    7
 1107          616   106.595     247.015    -246.735     -12.372      182.871     513.631     525.139     802.412    9
 1108          617   106.595     247.342     -20.213     246.515       94.688     513.572     525.143     805.276    5
 1109          616   106.591     247.258      87.927    -231.096      290.831     513.602     525.130     805.696    5
 1110          616   106.595     246.938    -225.760    -100.203      203.934     513.588     525.152     805.049   10
 1111          617   106.595     247.384    -108.767     222.191      116.083     513.569     525.177     807.333   10
 1112          616   106.594     247.015     169.479    -179.705      313.322     513.584     525.119     807.725    6
 1113          617   106.593     246.725    -172.355    -175.680      225.710     513.490     525.126     798.914    9
 1114          616   106.588     247.479     115.117     219.075       62.279     513.616     525.114     807.326   11
 1115          617   106.594     246.771     225.691     -99.728      336.145     513.476     525.096     800.706    8
 1116          616   106.593     247.370    -246.034      25.668      174.044     513.498     525.139     800.619    8
 1117          617   106.588     247.339      17.444     245.723       85.956     513.498     525.094     805.039    5
 1118          616   106.588     247.025      60.197    -239.578      284.104     513.491     525.098     804.890    4
 1119          617   106.592     247.352    -235.046     -77.046      198.149     513.509     525.087     804.946   10
 1120          616   106.597     247.142     231.278     143.238       35.437     513.508     525.115     804.920   11
 1121          617   106.591     247.487     156.416    -193.142      309.729     513.505     525.083     810.457    6
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   EXCEDE II    HS-3 CVF   BASE1 ANALYSIS                                                      03/16/80  18.07.42.
SCAN          NPTS     FREQ          A          B           C         THETA      MEAN(HI)    MEAN(LO)    CHISQR  ITER
 1122          616   106.591    246.501   -209.913    129.226    148.383    513.514    525.071    794.983    8
 1123          617   106.586    247.767    119.754    216.904     61.097    513.386    525.105    813.093   11
 1124          616   106.589    246.717    -39.971   -243.458    260.676    513.511    525.112    798.923    2
 1125          617   106.591    247.537   -246.617     21.330    175.057    513.435    525.120    805.536    8
 1126          616   106.595    247.225    241.040     54.953     12.843    513.437    525.067    806.522    7
 1127          617   106.596    246.949     73.032   -235.902    287.202    513.461    525.059    800.689    5
 1128          616   106.589    247.620   -150.049    196.979    127.298    513.461    525.076    808.943   10
 1129          617   106.585    246.905    187.308    160.868     40.657    513.456    525.088    799.831   11
 1130          616   106.589    247.292   -118.852   -216.659    241.275    513.385    525.088    802.052    8
 1131          617   106.590    246.923   -225.452    100.710    155.929    513.398    525.059    802.990    7
 1132          616   106.569    247.442    246.671    -19.518    355.476    513.408    525.065    809.762    2
 1133          617   106.584    246.941     -3.304   -246.918    269.234    513.415    525.049    799.114    5
 1134          616   106.588    247.610    -85.639    232.329    110.234    513.391    525.053    808.929   11
 1135          617   106.583    246.917    225.383    100.603     24.054    513.384    525.048    794.382   10
 1136          616   106.568    247.435   -173.572   -176.343    225.454    513.369    525.026    804.960    9
 1137          617   106.587    247.175   -190.274    157.770    140.335    513.327    525.035    803.239    9
 1138          616   106.587    246.583    232.786    -81.627    340.677    513.423    525.046    794.265    7
 1139          617   106.585    248.268    -61.396   -240.557    255.682    513.486    525.038    815.039    2
 1140          616   106.588    245.877    -28.687    244.197     96.700    513.318    525.051    779.997    8
 1141          617   106.584    248.236    243.005     50.689     11.782    513.327    525.039    811.723    8
 1142          616   106.586    246.526   -207.252   -133.497    212.787    513.414    525.035    792.539   10
 1143          617   106.587    247.718   -155.969    192.453    129.022    513.323    525.027    806.516   10
 1144          616   106.565    247.319    213.395   -125.018    329.636    513.390    525.038    804.011    7
 1145          617   106.587    246.965    -99.642   -225.972    246.205    513.149    525.040    799.054    6
 1146          616   106.591    247.613     16.597    247.056     86.157    513.313    525.020    807.019    2
 1147          617   106.581    246.445    246.257      9.624      2.238    513.304    524.997    787.086    3
 1148          616   106.585    247.338   -225.103   -103.932    204.783    513.299    525.015    811.913   10
 1149          617   106.585    246.494   -127.774    210.792    121.223    513.298    525.002    789.896   10
 1150          616   106.554    248.348    198.111   -149.762    322.912    513.343    525.000    816.222    7
 1151          617   106.583    246.620   -125.184   -212.486    239.496    513.263    524.993    793.520    8
 1152          616   106.580    247.813     39.529    244.640     80.822    513.444    524.992    804.490    7
 1153          616   106.582    246.732    246.573     -8.866    357.941    513.356    525.003    796.407    2
 1154          617   106.590    247.047     21.306   -246.126    274.947    513.237    524.969    796.336    6
 1155          617   106.551    248.510   -114.437    220.593    117.419    513.183    524.982    819.834   10
 1156          616   106.583    245.918    188.345   -158.120    319.986    513.287    524.996    784.486    6
 1157          617   106.582    248.181   -134.241   -208.741    237.255    513.806    524.980    808.070    8
 1158          616   106.578    246.537     47.189    241.979     78.965    512.801    524.959    793.870    8
 1159          617   106.580    247.126    246.806    -12.581    357.082    513.271    524.969    798.570    2
 1160          616   106.592    247.011   -231.769    -85.427    200.233    512.942    524.981    804.032   10
 1161          617   106.582    247.387   -116.300    218.345    118.042    513.257    524.972    804.863   10
 1162          482   106.593    247.401    184.770   -164.522    318.318    513.285    524.961    826.669    9
 1163          482   106.581    246.542   -237.980    -64.407    195.144    513.234    524.954    800.051   10
 1164          616   106.579    247.507    247.507      -.309    359.928    513.203    524.966    804.145    2
 1165          617   106.576    247.044     32.546   -244.891    277.570    513.392    524.938    800.181    5
 1166          617   106.582    248.120   -132.678    209.667    122.326    513.186    524.959    822.339   10
 1167          616   106.581    246.527    203.958   -138.480    325.825    513.291    524.955    811.387    8
 1168          617   106.580    247.227   -106.068   -223.318    244.594    513.103    524.921    807.830    7
 1169          616   106.575    246.809     12.831    246.475     87.020    513.099    524.951    795.853    2
 1170          616   106.575    247.467    246.039     26.544      6.157    513.331    524.917    805.986    5
 1171          617   106.575    247.141     64.280   -238.635    285.076    513.054    524.908    799.861    5
 1172          616   106.579    246.714   -158.571    189.005    129.996    512.968    524.906    796.595    9
 1173          617   106.573    247.609    165.766    183.934     47.974    512.940    524.895    810.424   11
 1174          617   106.579    247.331    -69.804   -236.963    253.586    513.088    524.928    797.633    4
 1175          616   106.577    247.524    -32.788    245.343     97.612    513.117    524.923    808.598    8
 1176          617   106.572    247.224    237.439     68.866     16.174    513.010    524.942    797.733    9
 1177          616   106.577    247.143   -183.867   -165.144    221.929    513.035    524.923    805.917   10
 1178          617   106.577    247.185   -193.461    153.861    141.504    511.754    524.922    798.616    9
 1179          616   106.578    247.259    240.496    -57.434    346.569    512.884    524.916    803.754    5
 1180          616   106.574    247.188    -18.698   -246.480    265.662    512.601    524.886    806.019    4
 1181          617   106.577    246.749   -245.164    -27.920    186.497    511.724    524.861    797.710    9
 1182          616   106.572    247.908    213.257    126.412     30.658    511.285    524.861    806.179   11
 1183          617   106.576    247.102    164.610   -184.290    311.772    511.506    524.907    802.899    3
```

```
EXCEDE II     HS-3 CVF    PASE1 ANALYSIS                                                         07/16/80   18.07.42.
SCAN      NPTS   FREQ        A          B          C        THETA    MEAN(HI)   MEAN(LO)    CHISQR  ITER
1184      616   106.576   246.884   -227.184     95.640   156.956   512.411   524.891     802.398    8
1185      617   106.570   247.583     59.208    240.399    76.164   510.800   524.847     803.315    9
1186      617   106.572   246.437     52.230   -240.838   282.236   511.488   524.855     796.805    7
1187      616   106.574   249.371   -154.176    194.725   128.371   511.623   524.837     815.944   10
1188      616   106.570   245.797    155.280    183.279    47.956   511.566   524.899     794.894   11
1189      617   106.576   247.617    214.724   -123.319   330.131   511.328   524.876     808.357    7
1190      616   106.574   246.387   -246.263     17.540   175.926   511.240   524.876     814.894    8
1191      617   106.576   246.764    -32.502    244.614    97.568   511.122   524.892     798.735    7
1192      616   106.573   248.194    135.625   -207.861   303.124   511.151   524.876     818.872    2
1193      617   106.572   246.593   -176.617   -172.089   224.256   510.929   524.888     796.754   10
1194      616   106.567   247.706     96.487    232.117    69.564   506.860   524.852     809.797   10
1195      617   106.571   247.045    244.503    -35.351   351.773   508.162   524.812     815.772    6
1196      616   106.572   246.394   -233.654    -79.766   198.849   508.269   524.782     799.794   10
1197      617   106.571   247.527   -125.457    213.378   120.454   505.269   524.825     810.542   10
1198      617   106.572   247.393    239.044   -132.303   327.670   507.573   524.861     809.363    7
1199      616   106.570   246.350   -245.755     23.226   174.601   506.791   524.798     796.061    9
1200      615   106.571   247.449    -30.265    245.591    97.025   506.907   524.815     808.953    8
1201      617   106.565   247.342    235.074     75.961    17.908   507.607   524.830     806.210   10
1202      616   106.571   247.376   -168.150   -181.031   227.113   503.188   524.789     801.122    9
1203      617   106.569   247.932   -213.405    125.421   149.557   507.190   524.831     809.095    8
1204      616   106.567   247.345    247.060    -11.882   357.247   505.240   524.780     807.309    2
1205      617   106.562   248.231     43.590   -244.374   280.114   505.217   524.805     841.213    2
1206      617   106.566   246.603   -157.070    188.812   129.757   505.915   524.792     798.150   10
1207      616   106.566   248.386    232.721    -85.954   339.729   505.978   524.771     814.728    7
1208      615   106.559   247.754    -29.397   -245.601   263.174   507.403   524.829     813.273    2
1209      617   106.564   246.727   -242.896    -43.311   190.110   500.616   524.722     816.401   10
1210      615   106.543   242.253    136.523    141.652    35.784   501.965   524.590    4075.958    7
1211      617   106.542   239.620    178.890   -159.423   318.293   504.421   524.523    2213.825   11
1212      616   106.562   252.597   -252.476      7.805   178.229   503.696   524.650    1161.204    2
1213      594   106.548   242.283    -48.716    237.335   101.600   511.600   527.363    2307.509    7
1214      572   105.667    52.393     52.657     -4.991   354.585   756.058   676.130   12078.866    5
1215      628   106.549   236.900   -130.759   -197.544   236.498   497.777   524.689    3378.802    5
1216      601   106.632   189.325    146.741    119.629    39.188   507.722   524.746   13060.294   22
1217      599   106.556   250.015    229.777    -98.539   336.788   509.023   524.712     951.093    8
1218      617   106.565   243.603   -136.513   -201.758   235.917   510.647   524.874     801.515    8
1219      616   106.554   249.443     11.002    249.201    87.472   511.431   525.261     834.723    2
1220      616   106.554   246.308    236.232     68.662    16.207   512.135   525.433     773.532    7
1221      617   106.555   248.109    144.240   -201.873   305.546   514.124   525.991     816.784    4
1222      616   106.555   245.464   -231.121     85.599   159.677   519.704   526.956     779.825    8
1223      617   106.552   248.372      5.361    248.314    88.763   521.239   528.356     798.073    2
1224      616   106.552   246.570    135.179   -206.212   303.246   526.287   529.911     782.908    2
1225      617   106.553   247.338   -146.565   -199.841   233.740   530.566   531.505     795.094    9
1226      616   106.549   247.130      7.739    246.908    88.205   534.503   533.778     784.915    2
1227      617   106.548   247.626    234.446     79.709    18.778   536.755   535.439     789.132    9
1228      616   106.551   247.445   -169.961   -204.058   235.554   541.166   537.089     782.165    8
1229      617   106.550   247.271   -240.881     55.652   166.946   546.747   539.806     781.621    7
1230      616   106.542   247.918    228.486     95.215    22.836   562.129   546.131     776.850   10
1231      617   106.546   246.845    180.962   -167.885   317.147   727.584   634.147     757.295    6
1232      616   106.549   248.109   -247.348     19.401   175.515   957.985   821.304     776.152    8
1233      617   106.550   247.395    -71.417    237.489   106.737   995.086   934.457     790.482   10
1234      616   106.553   249.749    201.760   -147.171   323.894   995.722   934.050     997.980   10
1235      617   106.552   243.539    -72.869   -232.382   252.590   995.973   933.768     773.332    6
1236      616   106.522   251.381    -61.631    244.327   104.157   995.992   933.248     835.835   10
1237      617   106.514   245.274    170.532    176.290    45.951   996.001   932.883     710.344   11
1238      616   106.512   248.322     24.164   -247.144   275.584   996.008   932.358     744.104    5
1239      617   106.490   249.228   -177.294   -175.161   224.653   996.015   932.032     826.003    8
1240      616   106.542   243.559    -57.561    236.758   103.669   996.015   931.731     861.595    2
1241      617   106.509   255.127    134.605    164.826    40.264   996.065   931.155     922.036   12
1242      616   106.470   237.057    -42.776   -233.173   259.614   996.175   930.899    1228.442    9
1243      617   106.420   256.704   -121.289   -226.243   241.804   996.281   930.384    1227.400    2
1244      614   106.461   231.556   -187.277    136.181   143.977   996.406   929.934    2022.907   11
1245      619   106.332   262.795     82.114   -249.636   288.208   996.556   929.447    1782.083    2
1246      617   106.444   232.760     23.514    231.569    84.202   996.671   929.075    1229.046    9
1247      616   106.284   250.185    220.730   -117.832   331.902   996.421   928.904    1538.355    8
```

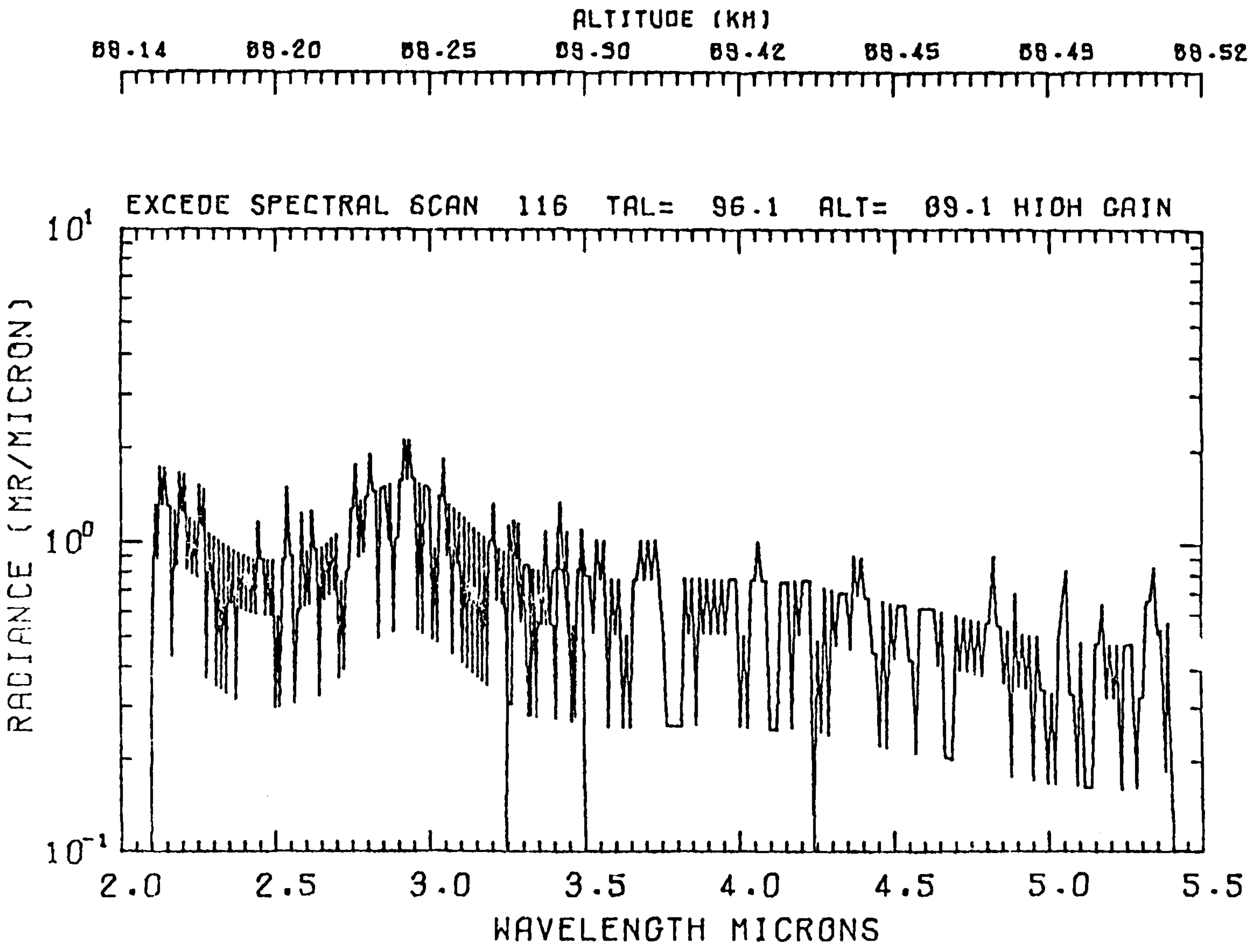
APPENDIX D

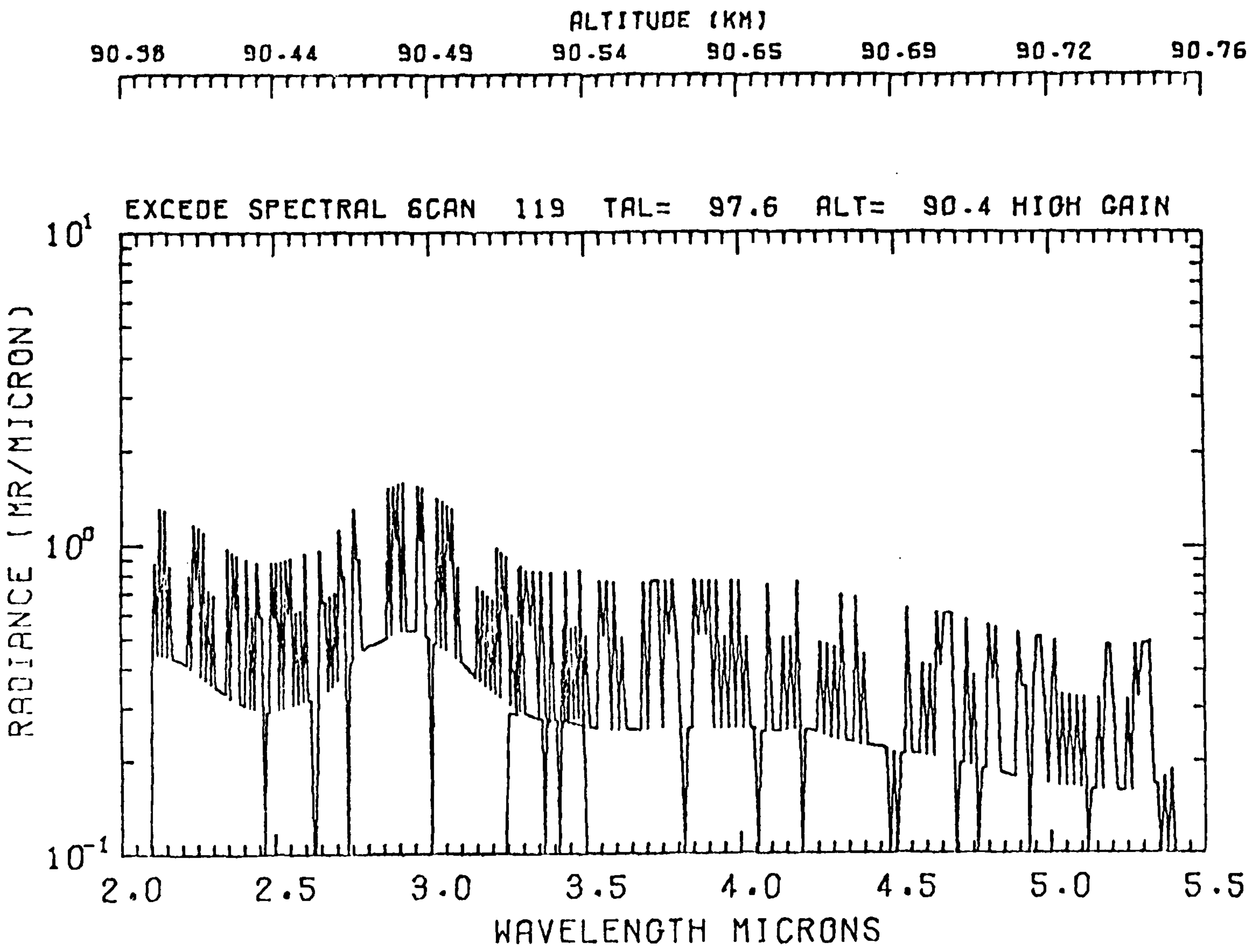
Sample Data Base for CVF NS-6-4

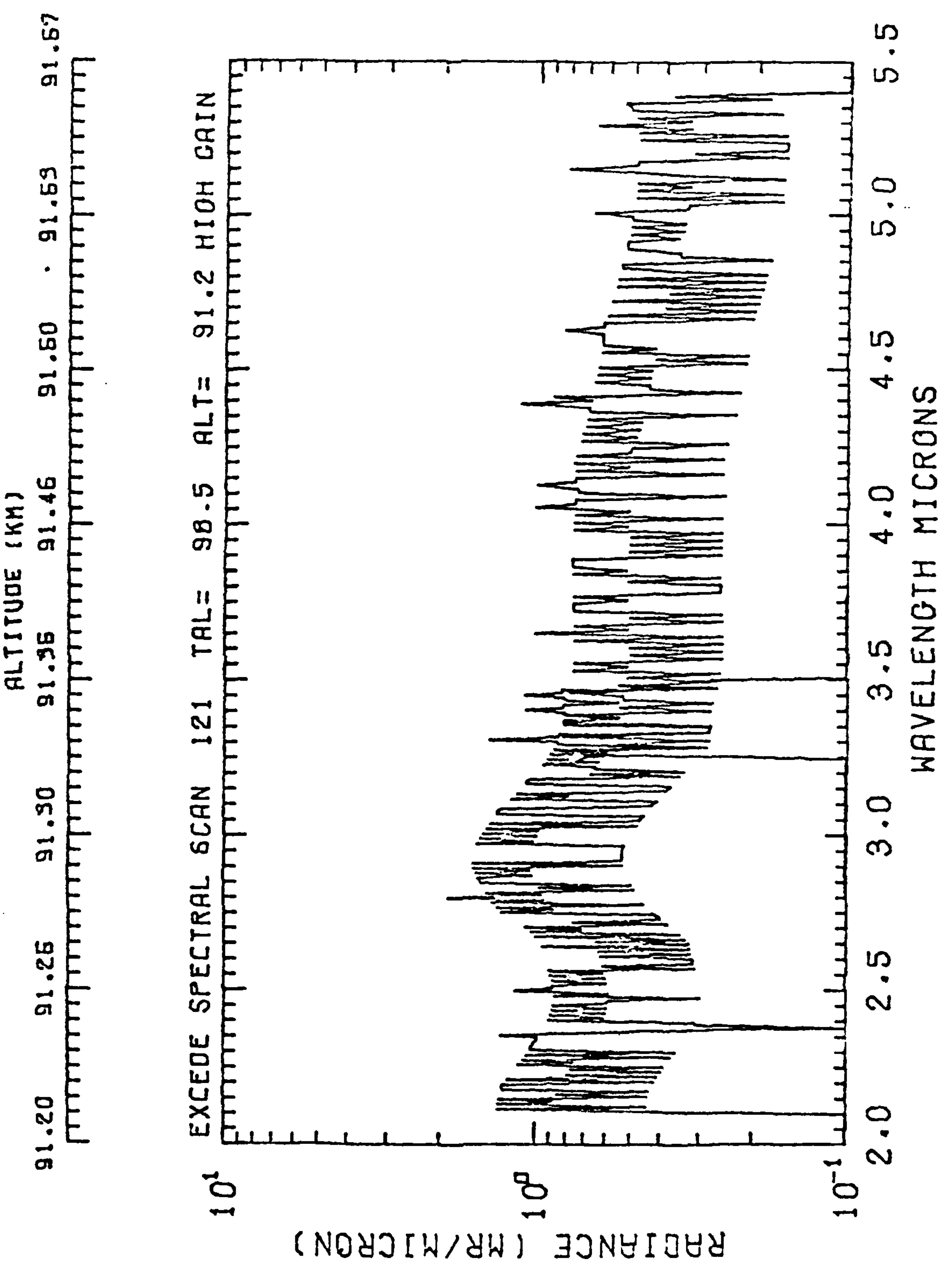
This appendix contains selected spectral data developed from CVF NS-6-4 measurements. Scans and scan start times (time after launch in seconds) follow

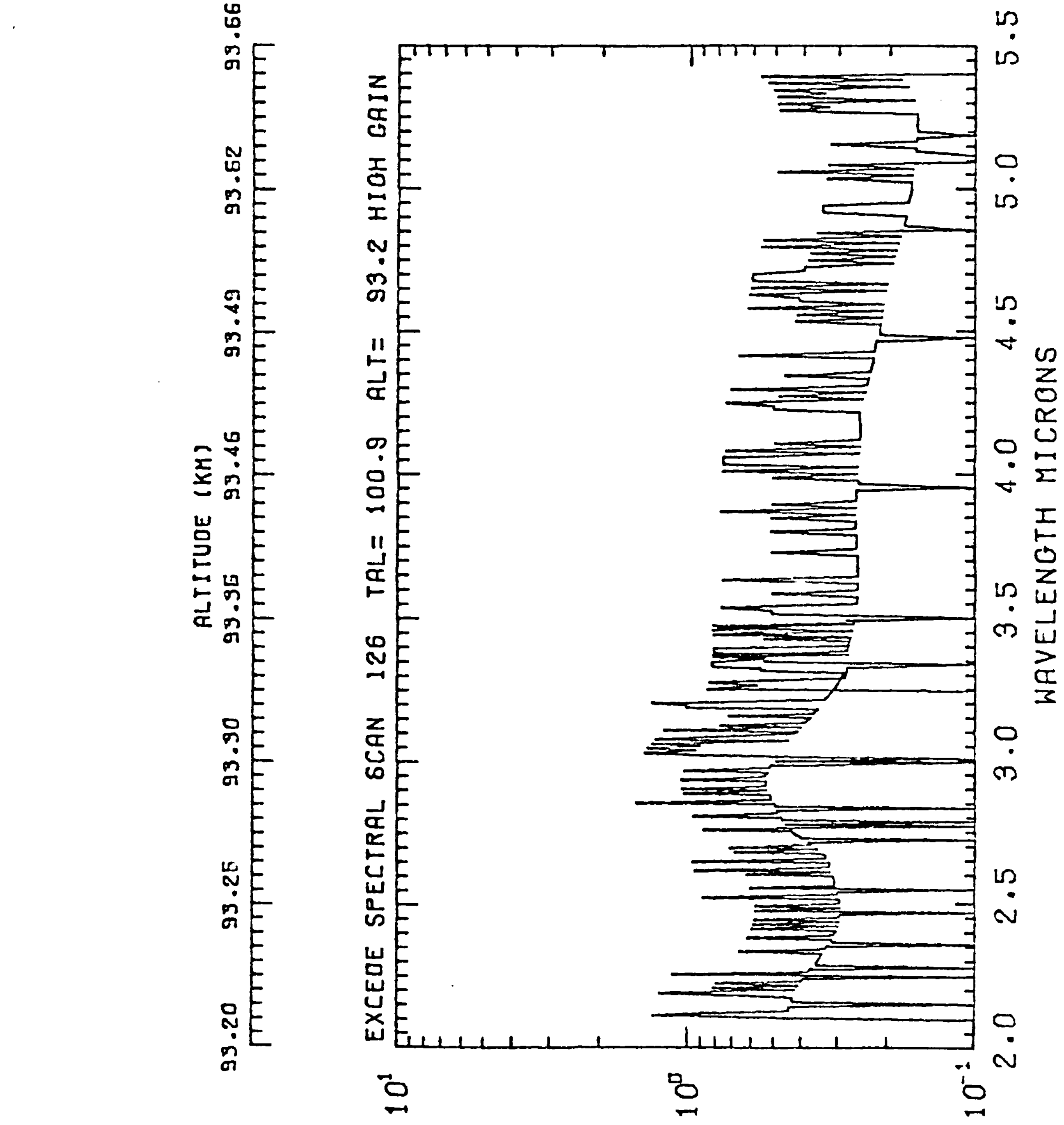
Scan	T.A.L.	Scan	T.A.L.
116	96.1080	271	171.4120
119	97.5590	276	173.8840
121	98.5300	395	232.7120
126	100.9500	424	247.0380
136	105.7810	447	257.6770
139	107.2340	467	267.3540
153	114.0030	487	277.0310
156	115.4520	-497	281.8680
159	116.9030	502	284.2890
171	122.7050	505	285.7450
174	124.1570	507	286.7110
181	127.5440	510	288.1610
223	147.8600	-512	289.1290
228	150.2780	520	292.9960
231	151.7300	-522	293.963

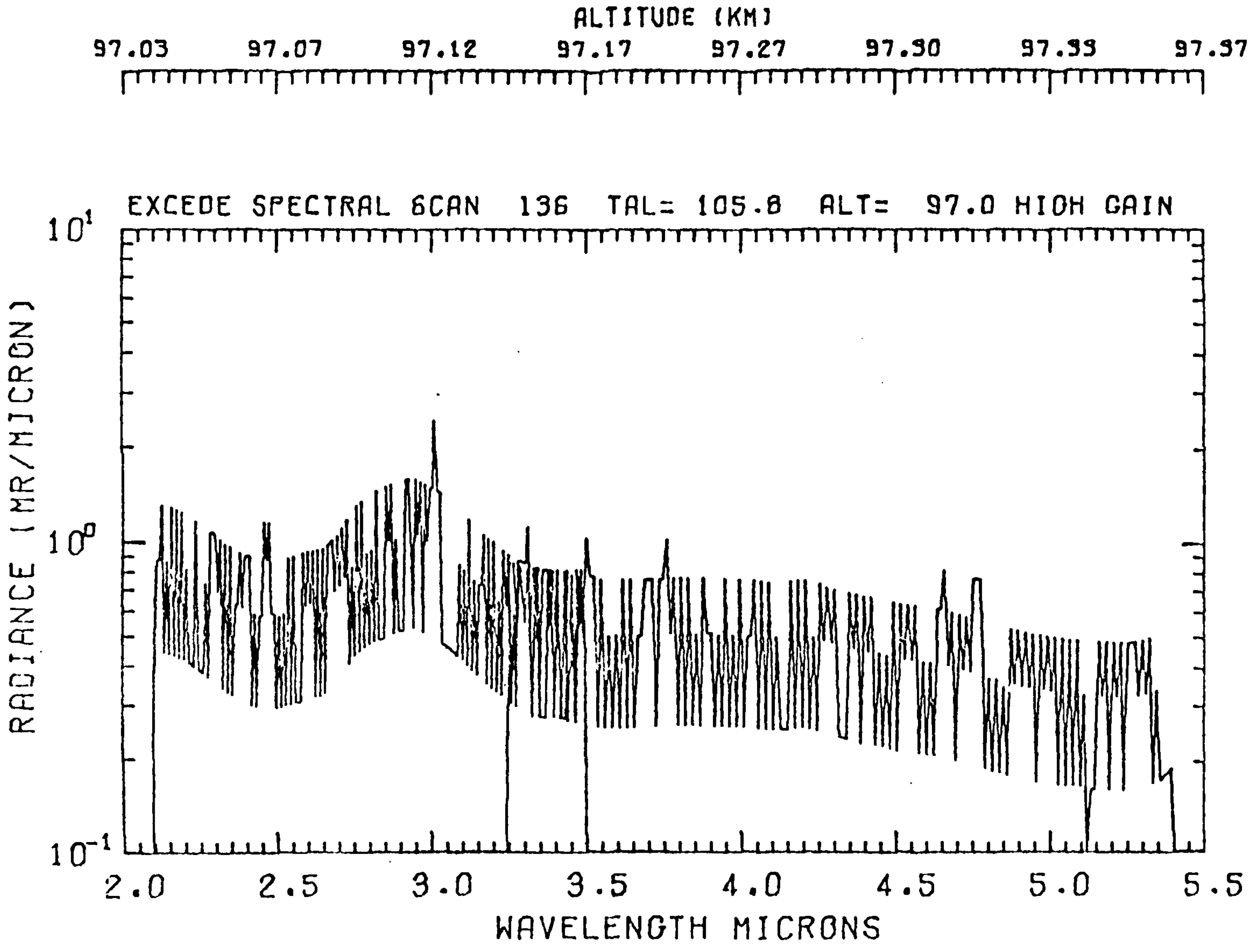
- indicates difficulty in detecting scan start time.

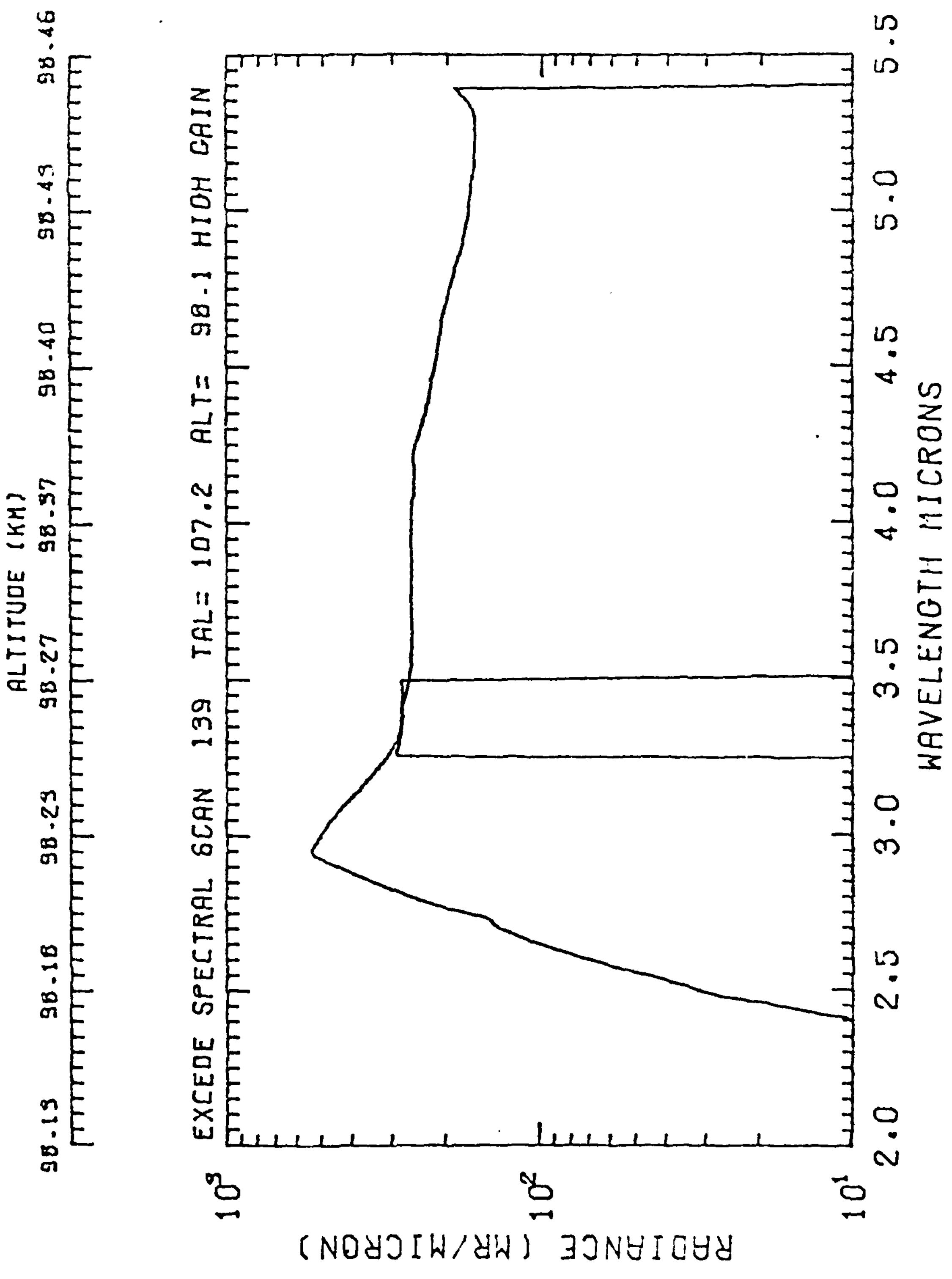
ALTITUDE (KM)
08.14
08.20
08.25
09.30
09.42
08.45
08.49
08.52
EXCEDE SPECTRAL SCAN 116 TAL= 96.1 ALT= 09.1 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

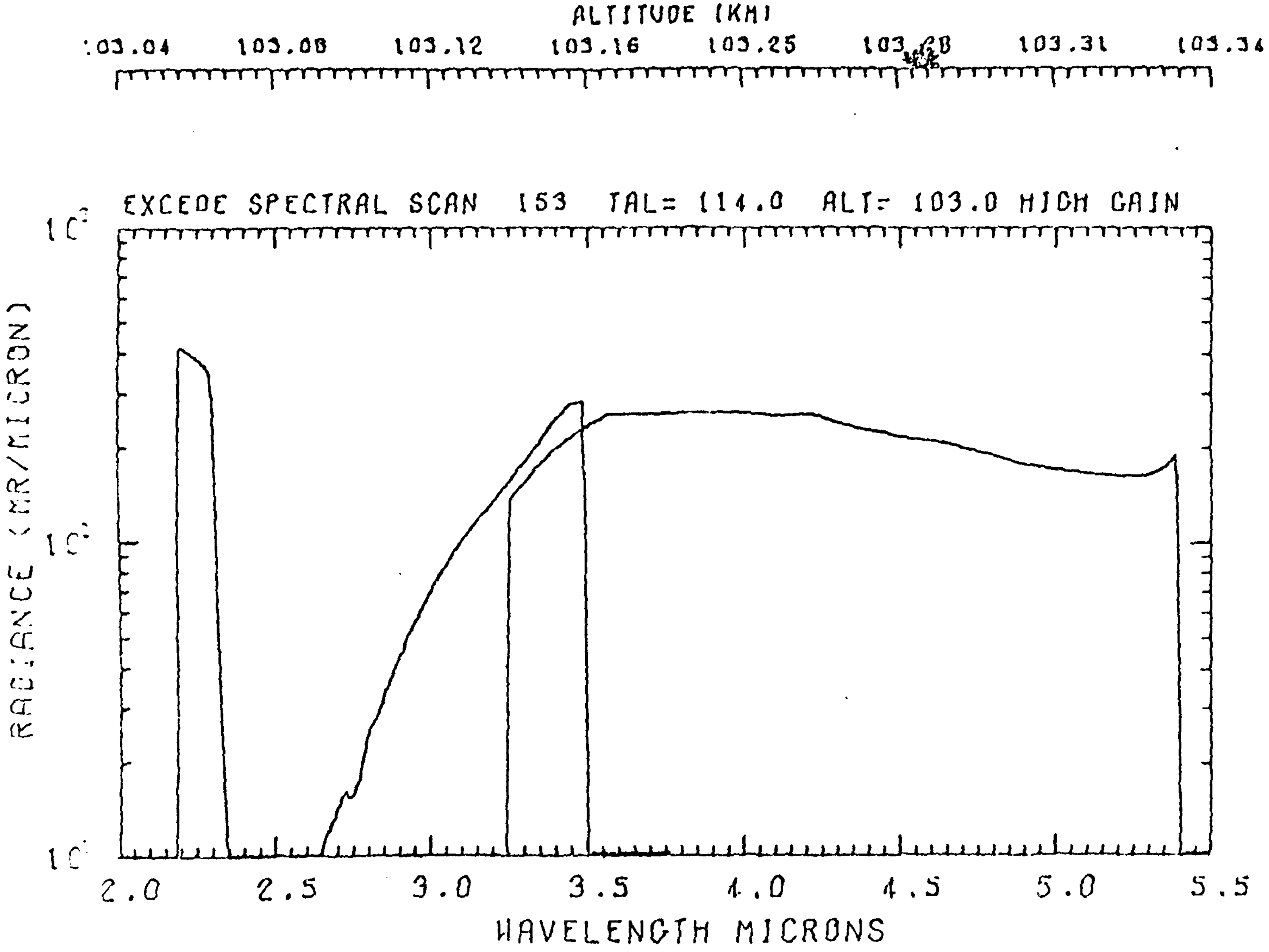

ALTITUDE (KM)
90.38
90.44
90.49
90.54
90.65
90.69
90.72
90.76
EXCEDE SPECTRAL SCAN 119 TAL= 97.6 ALT= 90.4 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

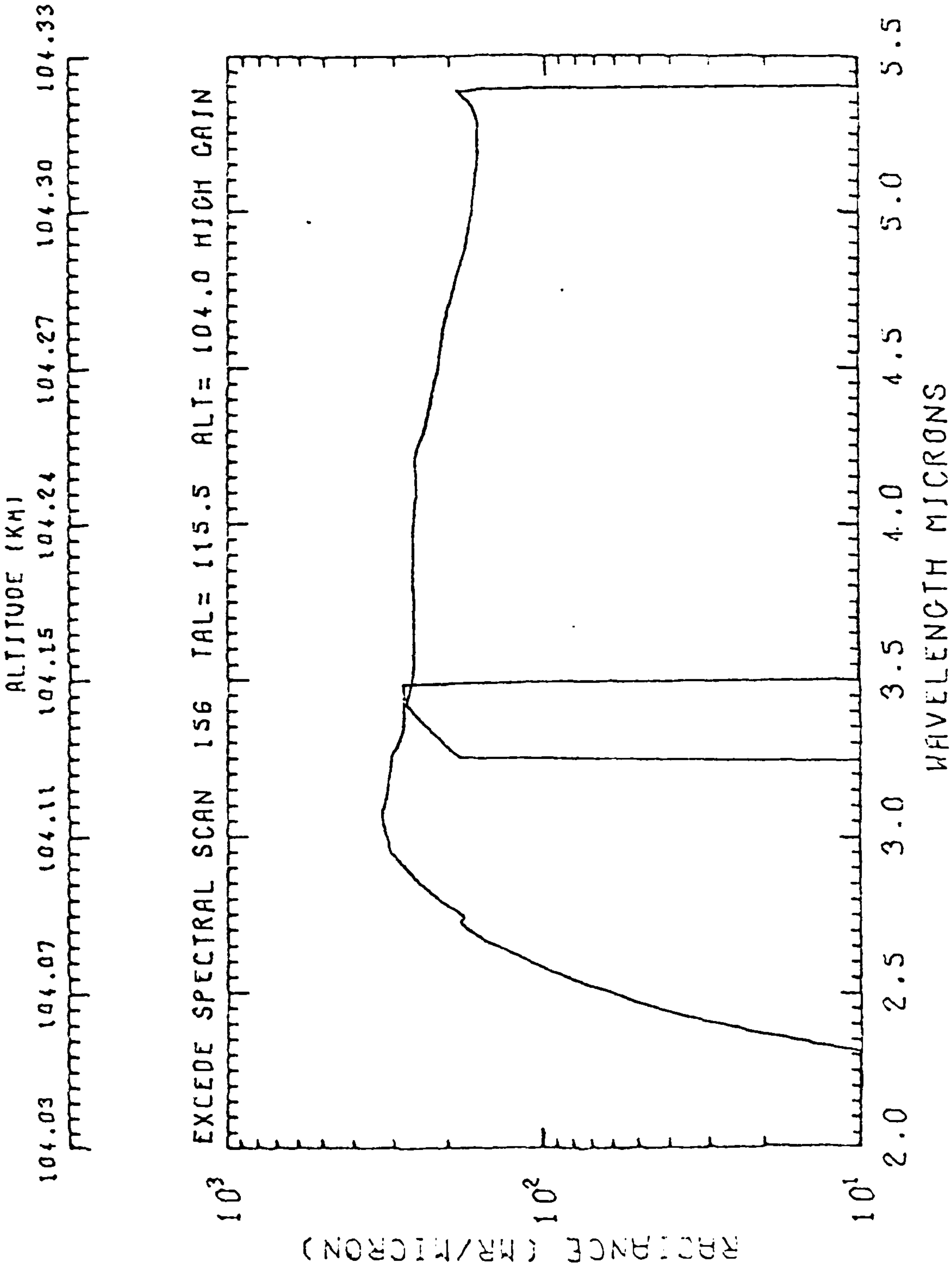

EXCEDE SPECTRAL SCAN 121 TAL= 98.5 ALT= 91.2 HIGH GAIN
ALTITUDE (KM)
91.20
91.26
91.30
91.36
91.46
91.50
91.53
91.57
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

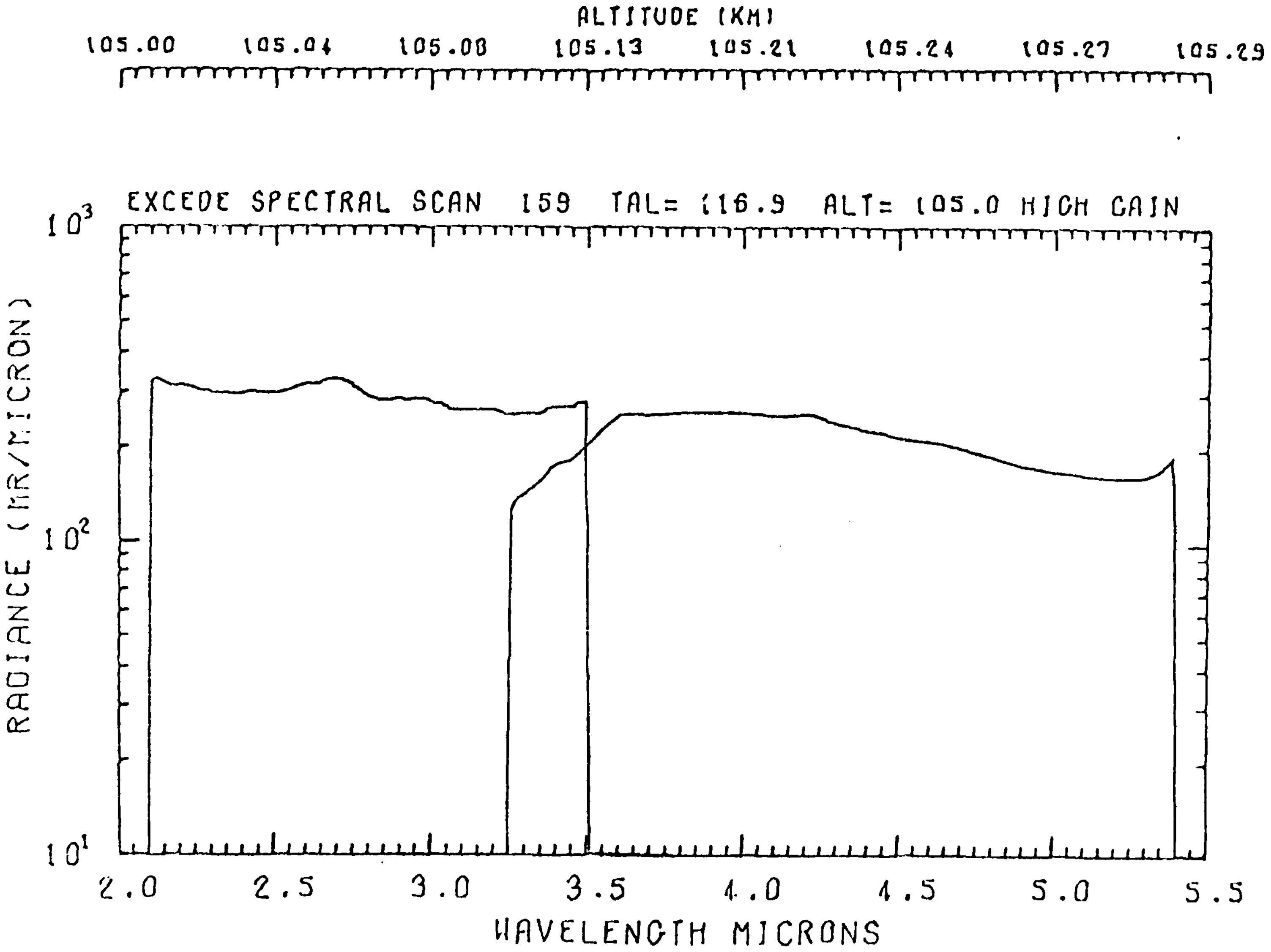

EXCEDE SPECTRAL SCAN 126 TAL= 100.9 ALT= 93.2 HIGH GAIN
ALTITUDE (KM)
93.20
93.25
93.30
93.36
93.46
93.49
93.62
93.66
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

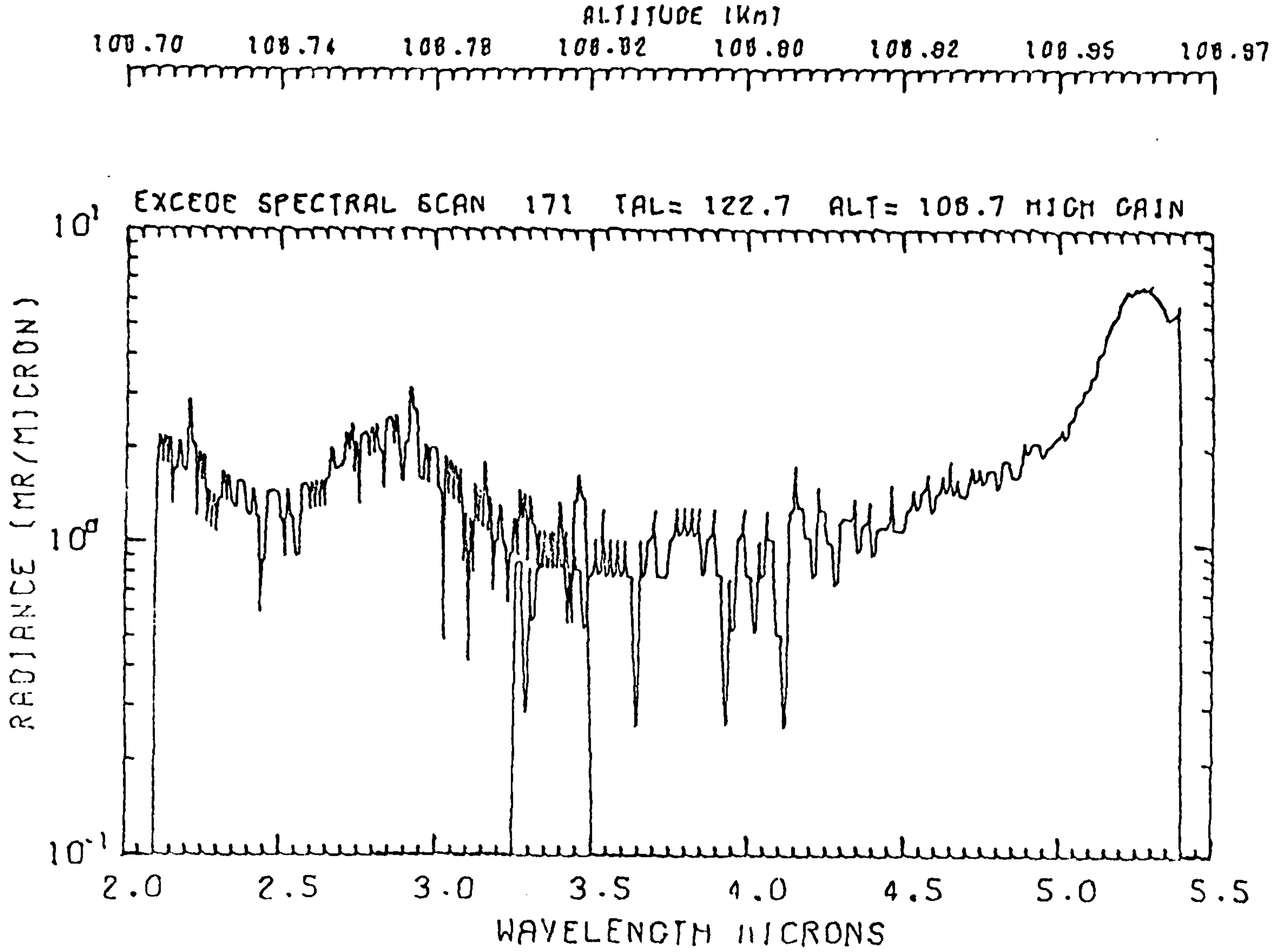

ALTITUDE (KM)
97.03
97.07
97.12
97.17
97.27
97.30
97.33
97.37
EXCEDE SPECTRAL SCAN 136 TAL= 105.8 ALT= 97.0 HIGH GAIN
10^1
10^0
10^{-1}
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

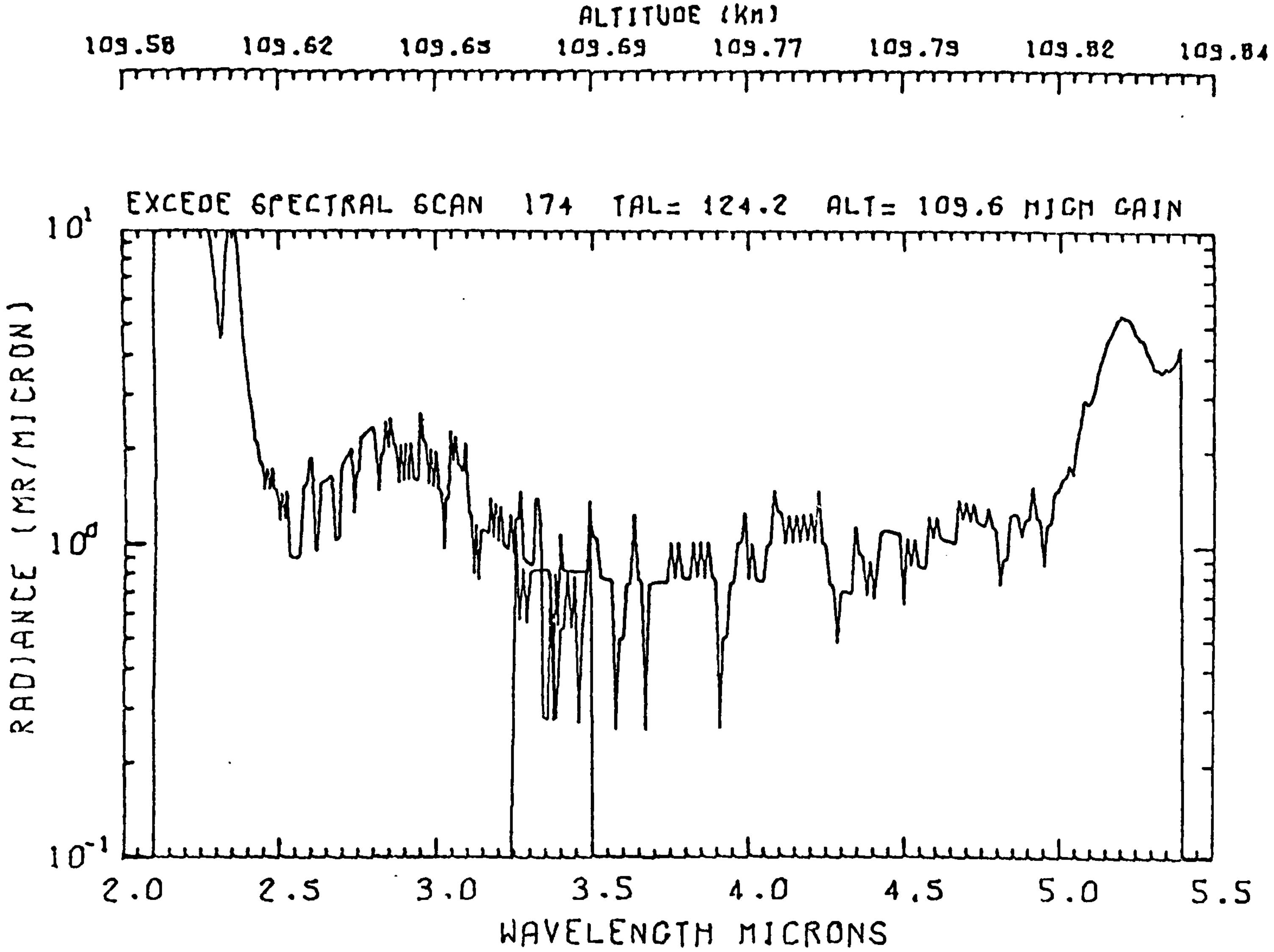

ALTITUDE (KM)
98.13
98.18
98.23
98.27
98.37
98.40
98.43
98.46
EXCEDE SPECTRAL SCAN 139 TAL= 107.2 ALT= 98.1 HIGH GAIN
RADIANCE (MR/MICRON)
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

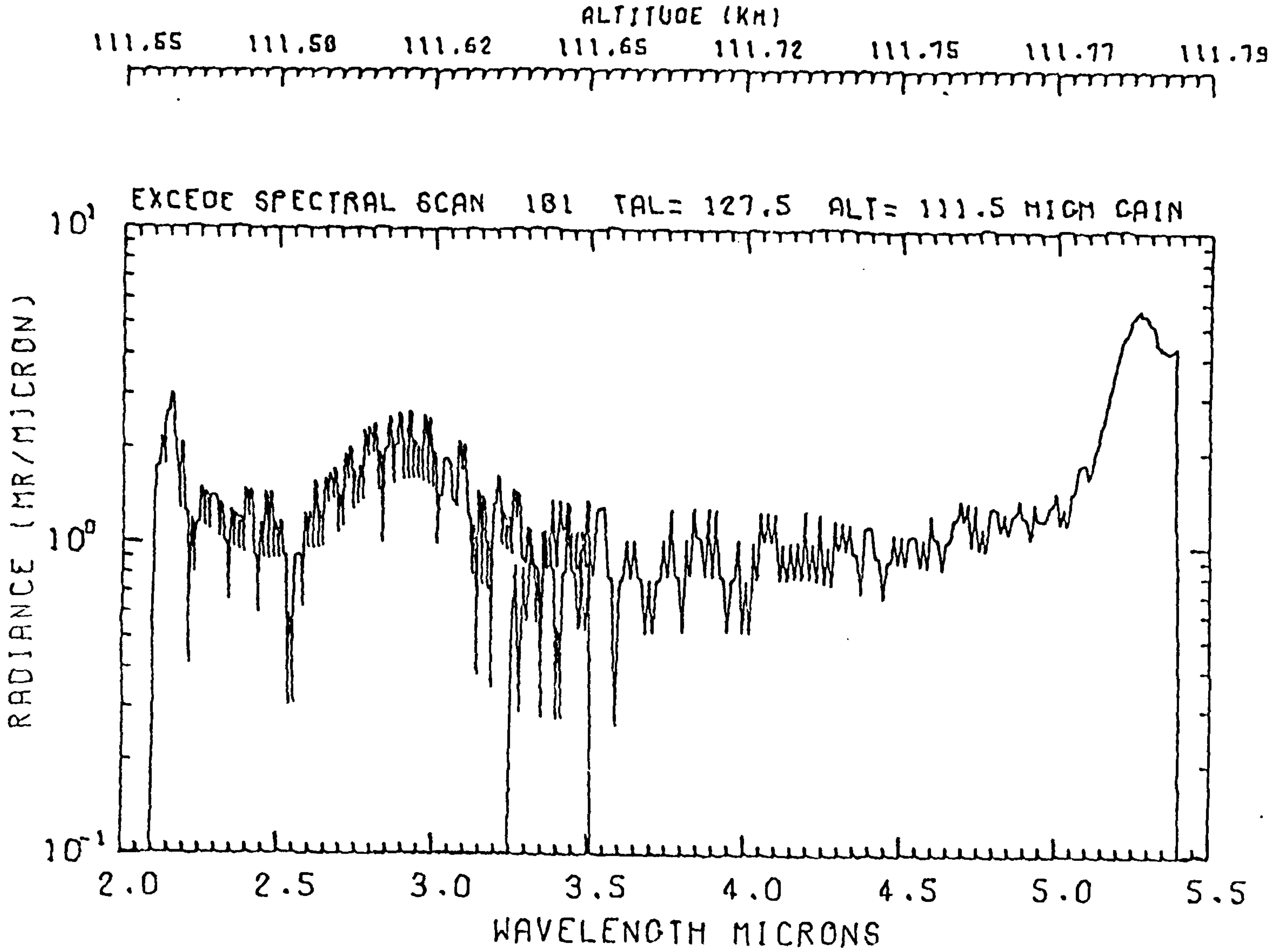

ALTITUDE (KM)
103.04
103.08
103.12
103.16
103.25
103.28
103.31
103.34
EXCEDE SPECTRAL SCAN 153 TAL= 114.0 ALT= 103.0 HIGH GAIN
RADIANCE (MR/MICRON)
10^2
10^1
10^0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

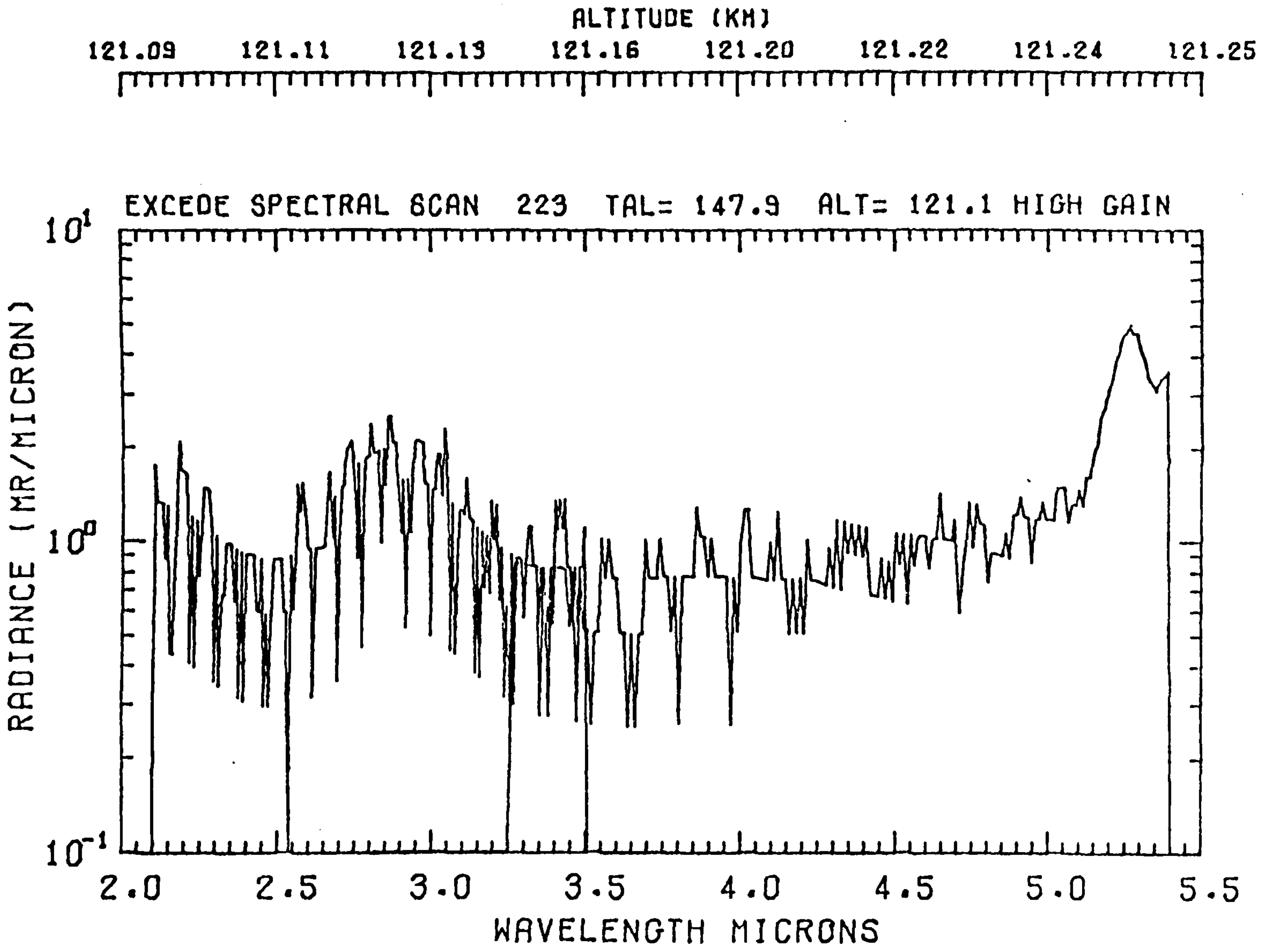

ALTITUDE (KM)
104.03
104.07
104.11
104.15
104.24
104.27
104.30
104.33
EXCEDE SPECTRAL SCAN 156 TAL= 115.5 ALT= 104.0 HIGH GAIN
RADIANCE (MR/MICRON)
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

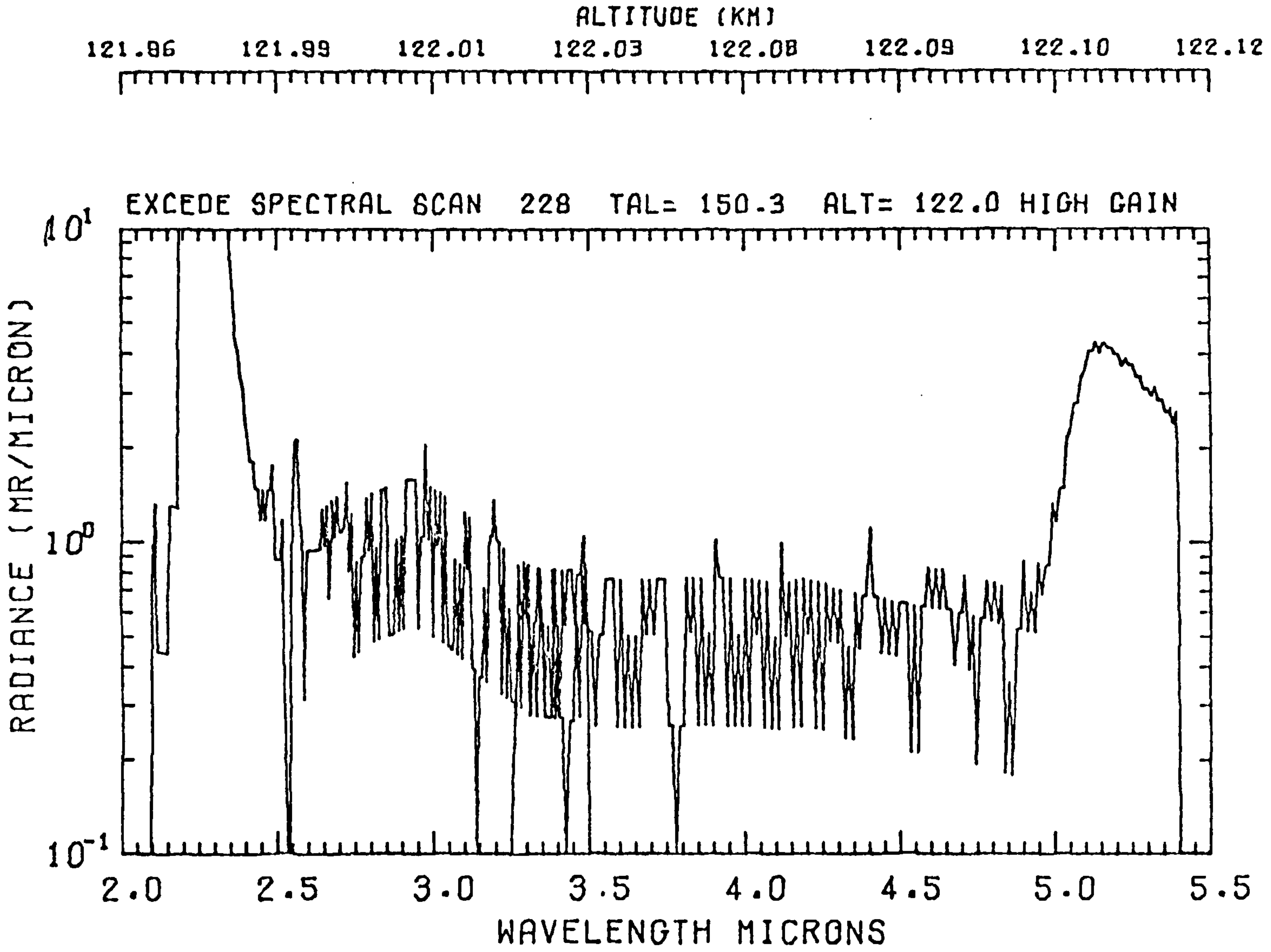

ALTITUDE (KM)
105.00
105.04
105.08
105.13
105.21
105.24
105.27
105.29
EXCEDE SPECTRAL SCAN 159 TAL= 116.9 ALT= 105.0 HIGH GAIN
10^3
10^2
10^1
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

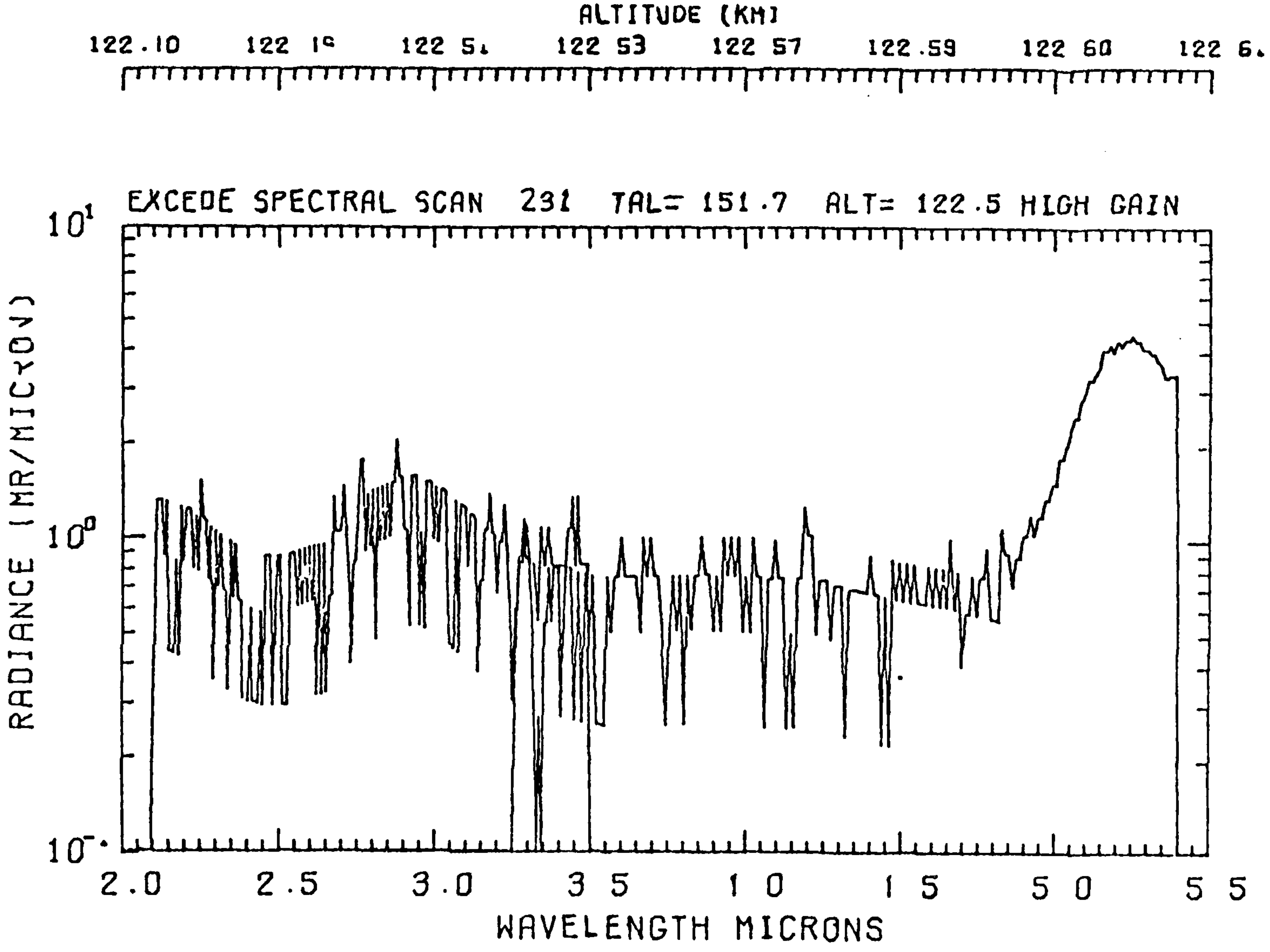

ALTITUDE (Km)
108.70
108.74
108.78
108.82
108.80
108.82
108.95
108.97
EXCEDE SPECTRAL SCAN 171 TAL= 122.7 ALT= 108.7 HIGH GAIN
10¹
10⁰
10⁻¹
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

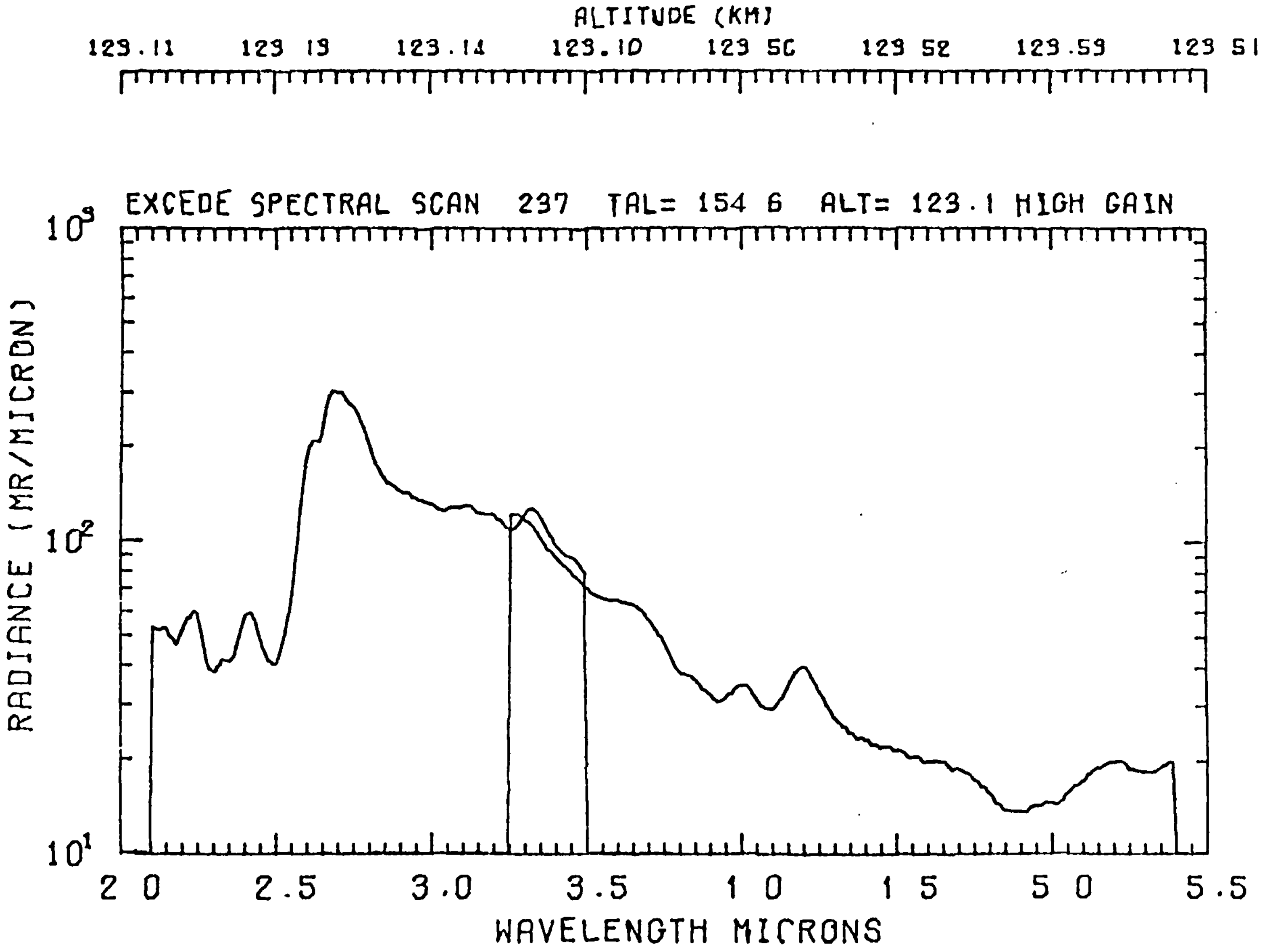

ALTITUDE (KM)
109.58
109.62
109.65
109.69
109.77
109.79
109.82
109.84
EXCEDE SPECTRAL SCAN 174 TAL= 124.2 ALT= 109.6 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

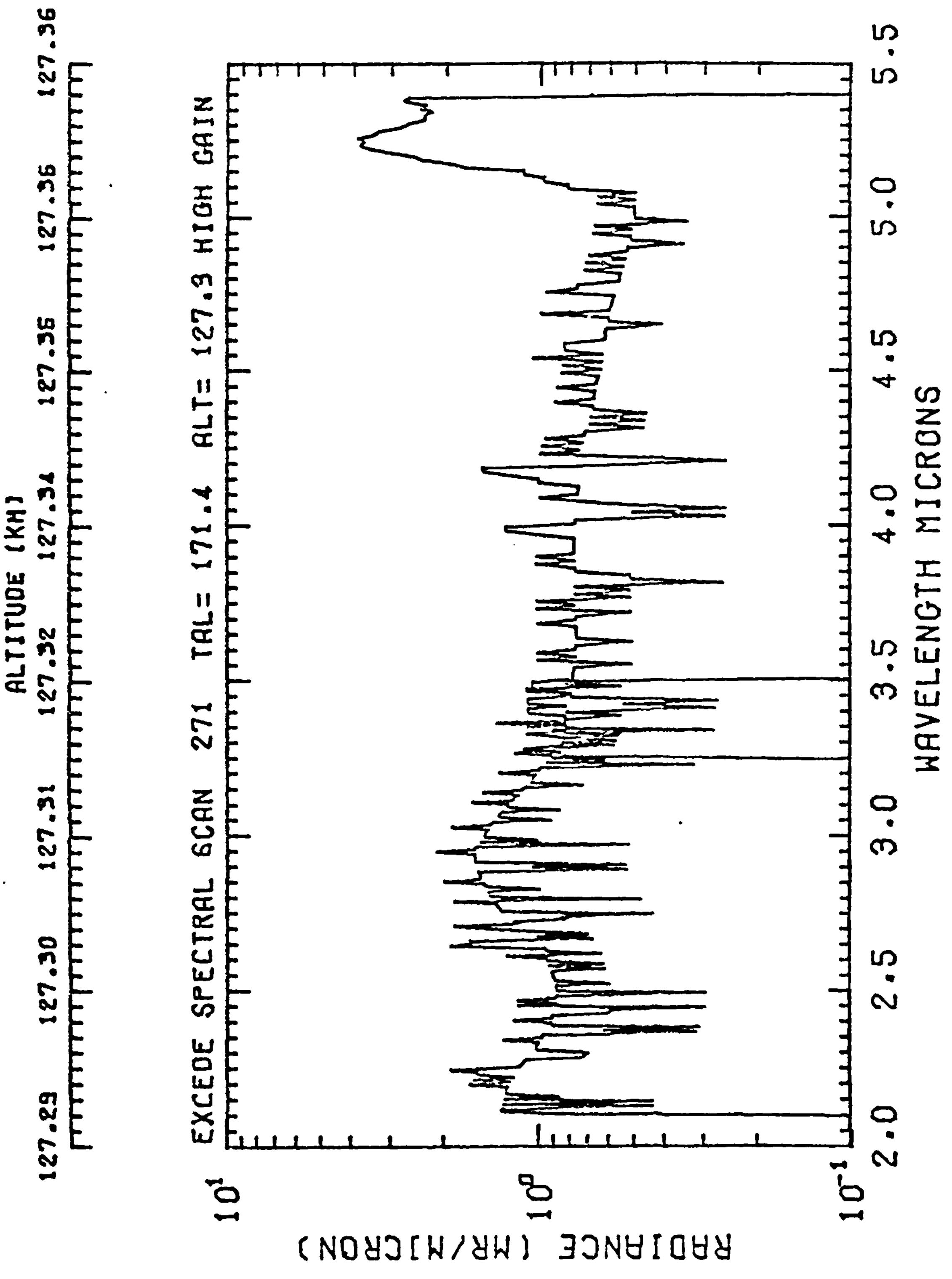

ALTITUDE (KM)
111.55
111.58
111.62
111.65
111.72
111.75
111.77
111.79
EXCEDE SPECTRAL SCAN 181 TAL= 127.5 ALT= 111.5 HIGH GAIN
10^1
10^0
10^{-1}
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

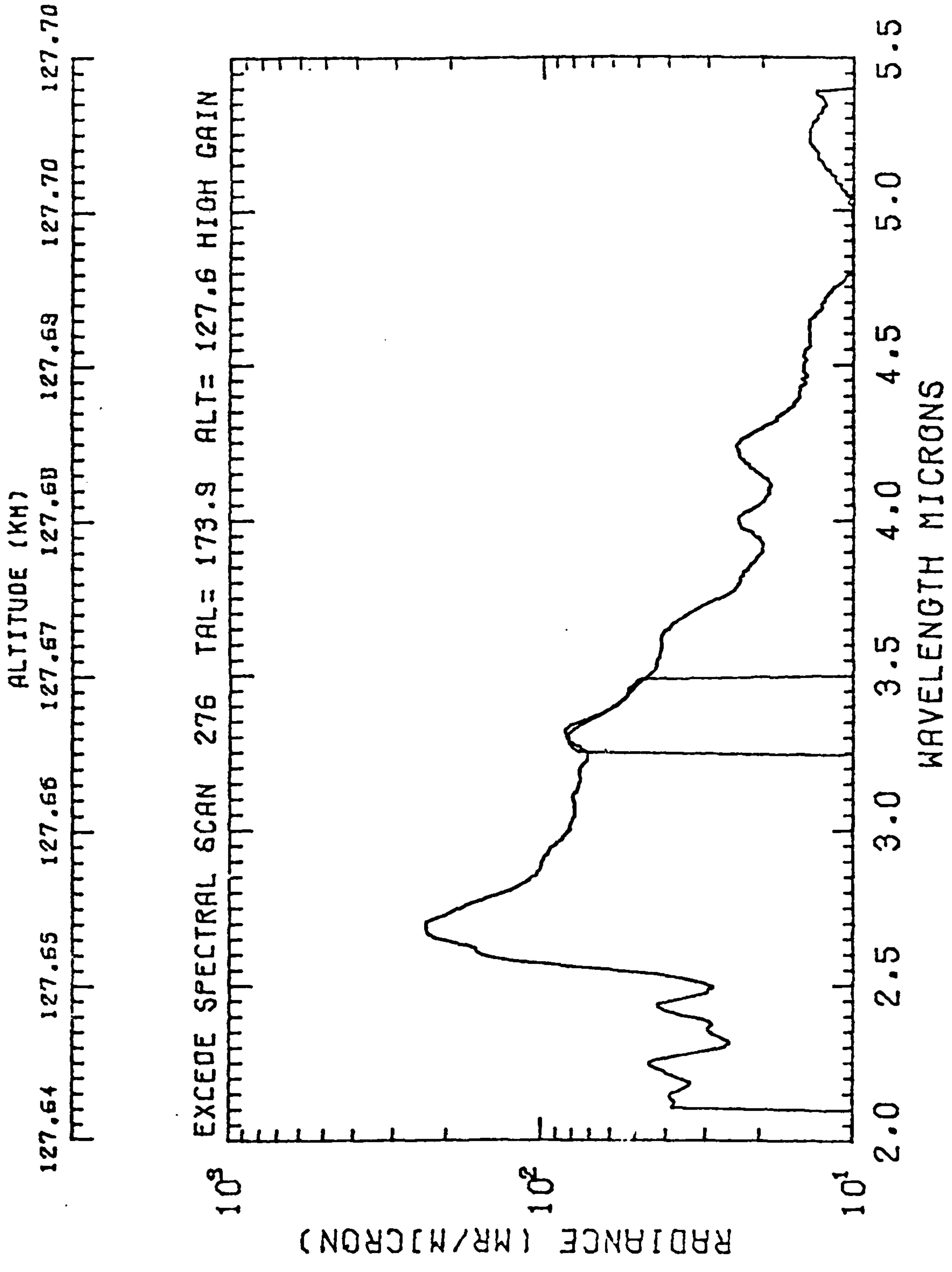

ALTITUDE (KM)
121.09
121.11
121.13
121.16
121.20
121.22
121.24
121.25
EXCEDE SPECTRAL SCAN 223 TAL= 147.9 ALT= 121.1 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

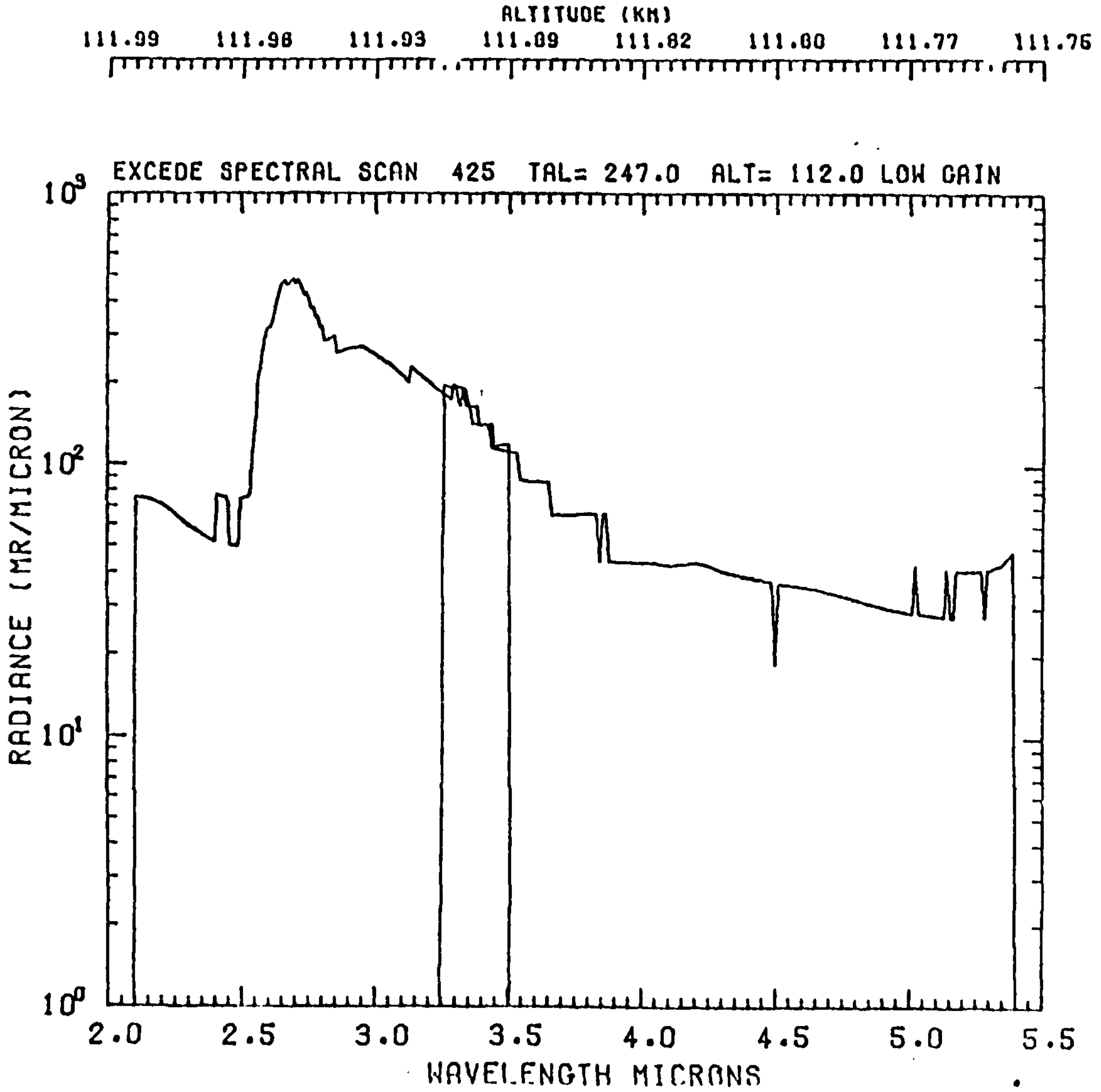

ALTITUDE (KM)
121.86
121.99
122.01
122.03
122.08
122.09
122.10
122.12
EXCEDE SPECTRAL SCAN 228 TAL= 150.3 ALT= 122.0 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

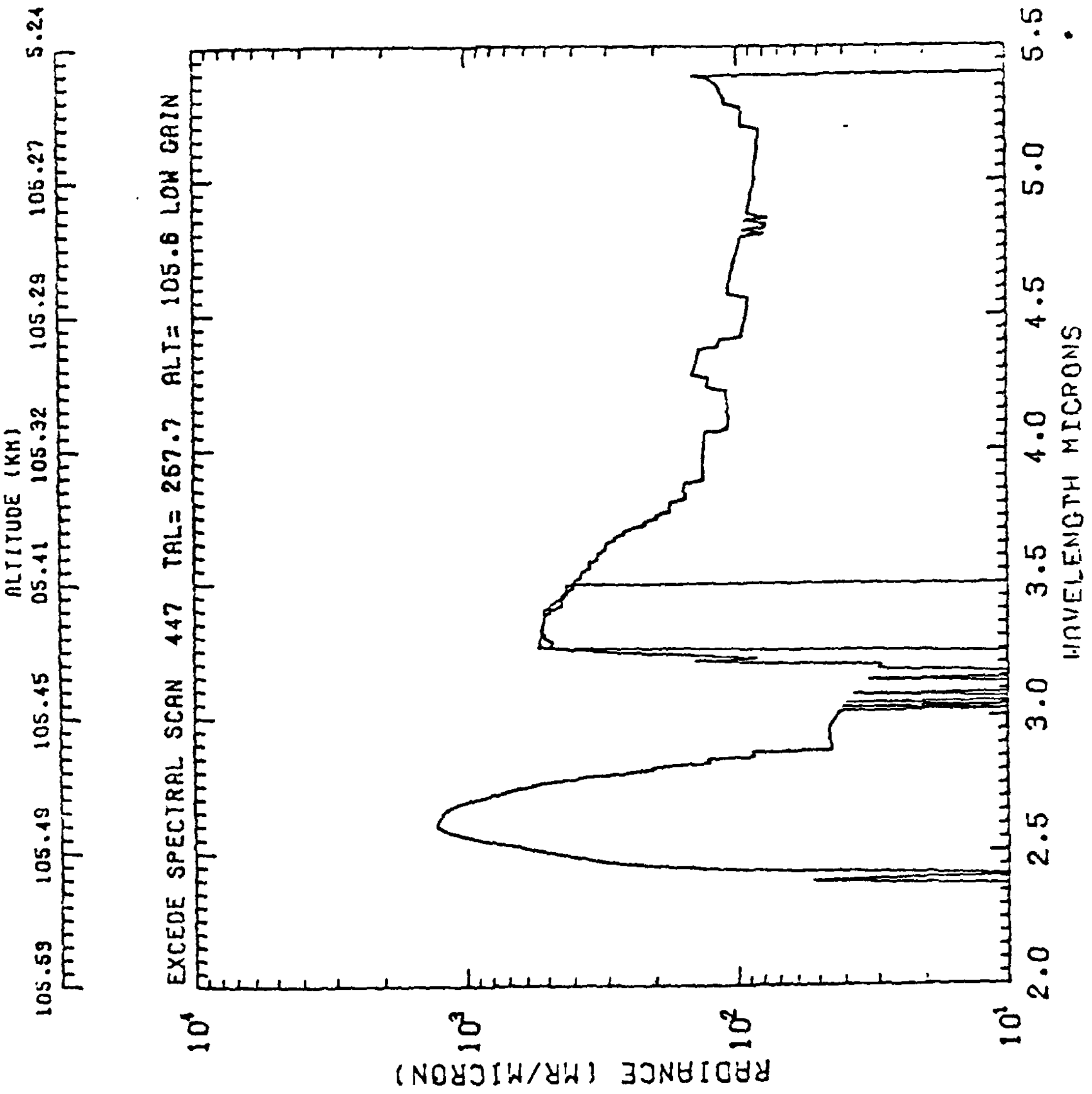

ALTITUDE (KM)
122.10
122 1c
122 5.
122 53
122 57
122.59
122 60
122 6.
EXCEDE SPECTRAL SCAN 231 TAL= 151.7 ALT= 122.5 HIGH GAIN
RADIANCE (MR/MICRON)
10^1
10^0
10^{-1}
2.0
2.5
3.0
3 5
1 0
1 5
5 0
5 5
WAVELENGTH MICRONS

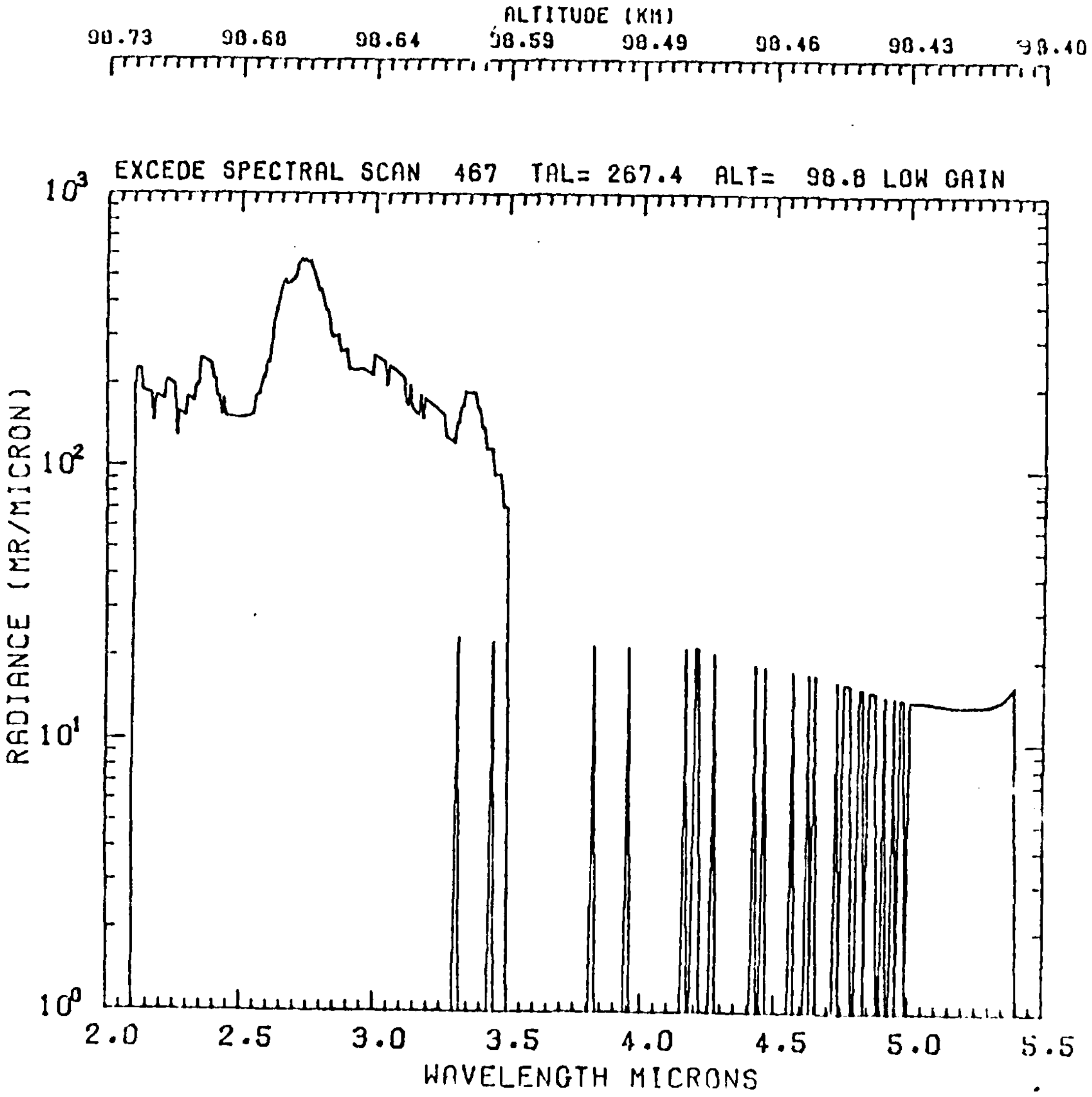

ALTITUDE (KM)
123.11
123 13
123.14
123.10
123 5C
123 52
123.53
123 51
EXCEDE SPECTRAL SCAN 237 TAL= 154 6 ALT= 123.1 HIGH GAIN
10^3
10^2
10^1
RADIANCE (MR/MICRON)
2 0
2.5
3.0
3.5
1 0
1 5
5 0
5.5
WAVELENGTH MICRONS


ALTITUDE (KM)
127.29
127.30
127.31
127.32
127.34
127.35
127.36
127.36
EXCEDE SPECTRAL SCAN 271 TAL= 171.4 ALT= 127.3 HIGH GAIN
10^1
10^0
10^{-1}
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS


ALTITUDE (KM)
127.64
127.65
127.66
127.67
127.60
127.69
127.70
127.70
EXCEDE SPECTRAL SCAN 276 TAL= 173.9 ALT= 127.6 HIGH GAIN
RADIANCE (MR/MICRON)
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS


ALTITUDE (KM)
111.99
111.98
111.93
111.89
111.82
111.80
111.77
111.76
EXCEDE SPECTRAL SCAN 425 TAL= 247.0 ALT= 112.0 LOW GAIN
10^3
10^2
10^1
10^0
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS


ALTITUDE (KM)
105.59
105.49
105.45
05.41
105.32
105.29
105.27
5.24
EXCEDE SPECTRAL SCAN 447 TAL= 267.7 ALT= 105.6 LOW GAIN
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS


ALTITUDE (KM)
98.73
98.68
98.64
98.59
98.49
98.46
98.43
98.40
EXCEDE SPECTRAL SCAN 467 TAL= 267.4 ALT= 98.8 LOW GAIN
RADIANCE (MR/MICRON)
10^3
10^2
10^1
10^0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

AD-A109 894 BOSTON COLL CHESTNUT HILL MA SPACE DATA ANALYSIS LAB F/G 20/6
ANALYSIS OF PROJECT EXCEDE II CIRCULAR VARIABLE FILTER SPECTROM--ETC(U)
JAN 81 W F GRIEDER, C I FOLEY F19628-79-C-0139
UNCLASSIFIED BC-SDAL-80-3 AFGL-TR-81-0224 NL

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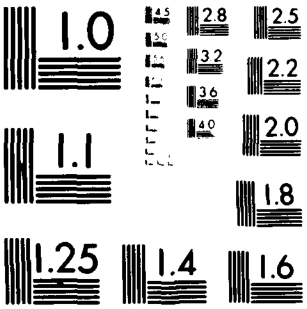
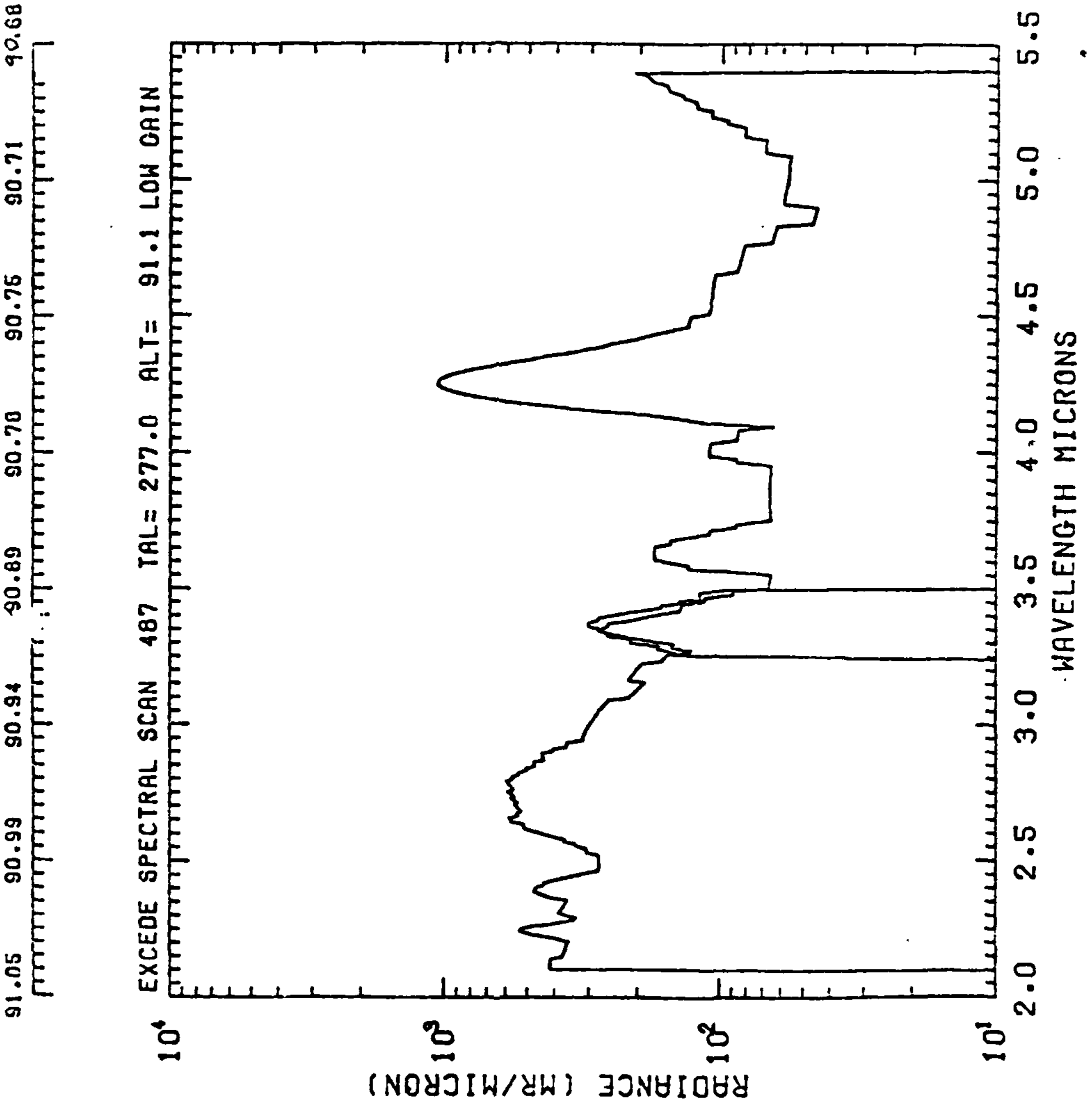
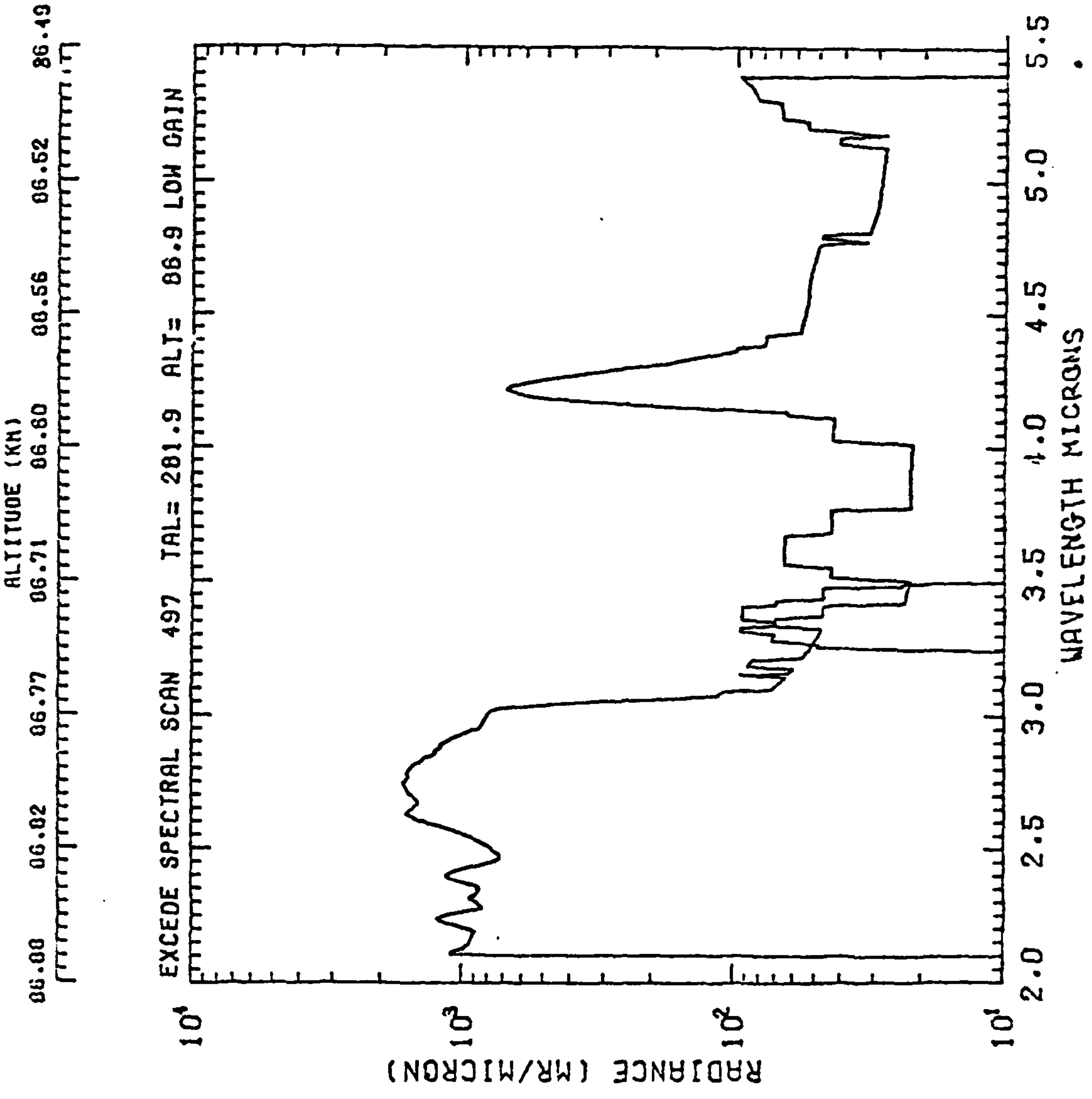
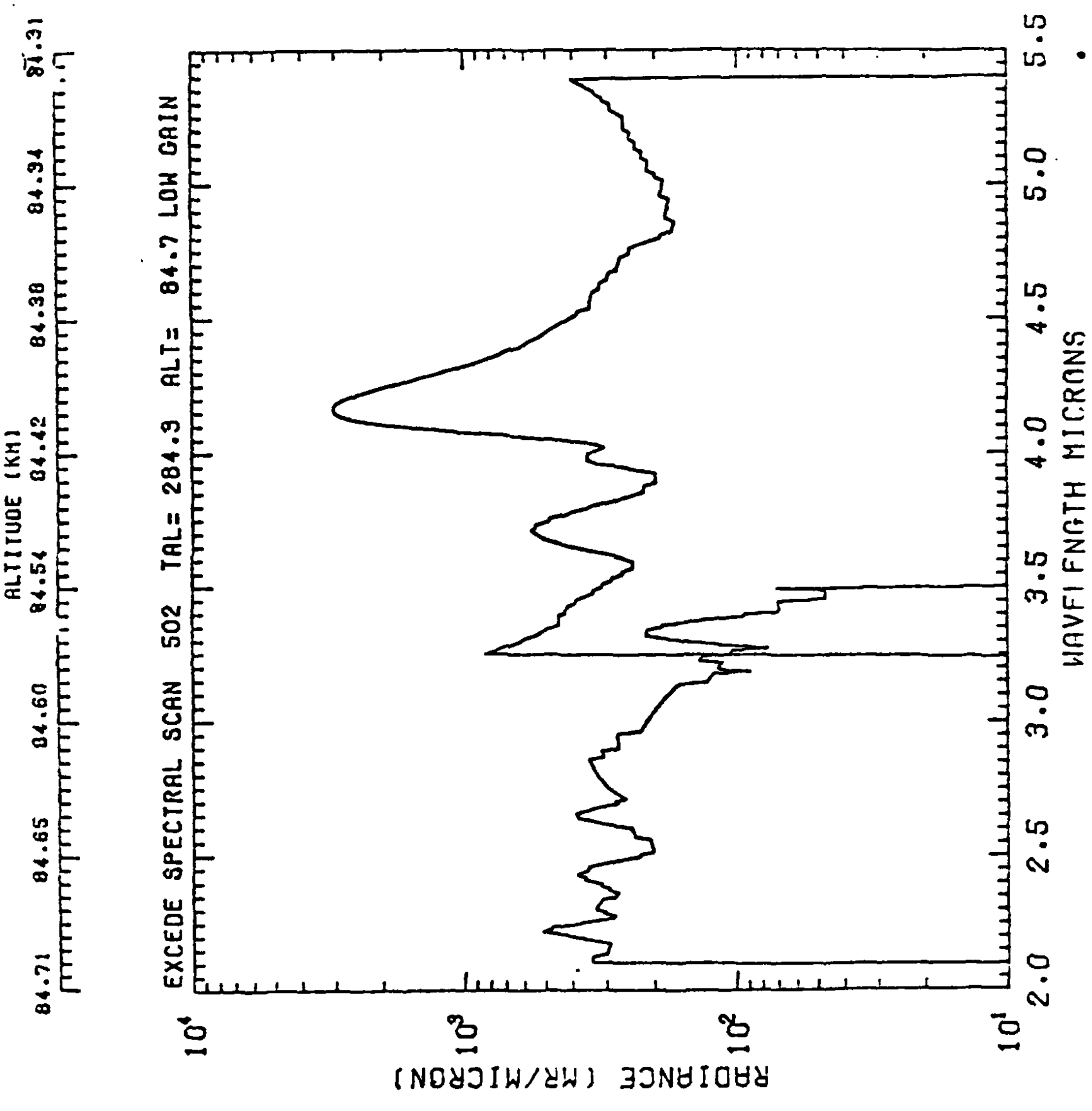
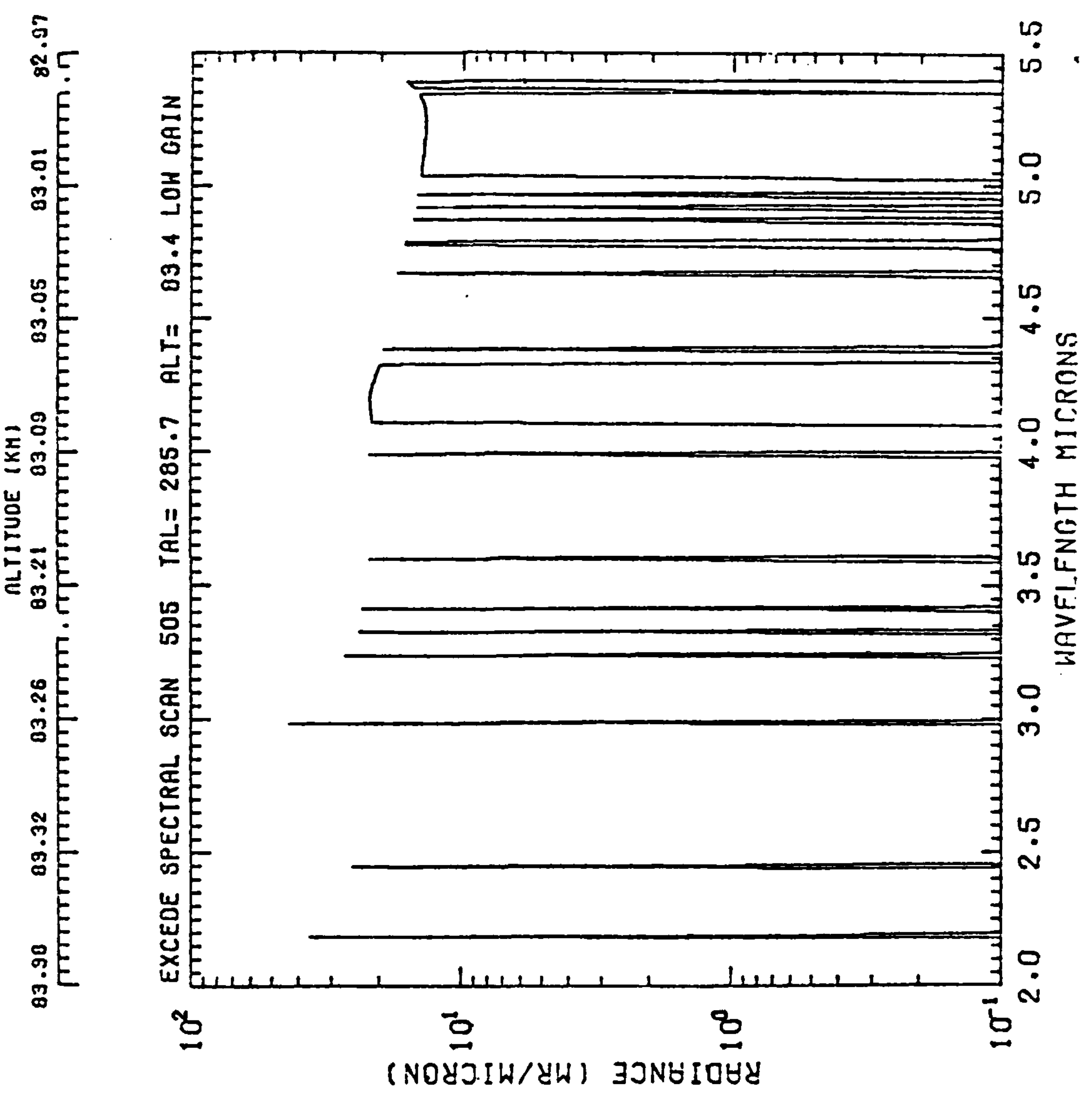

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0

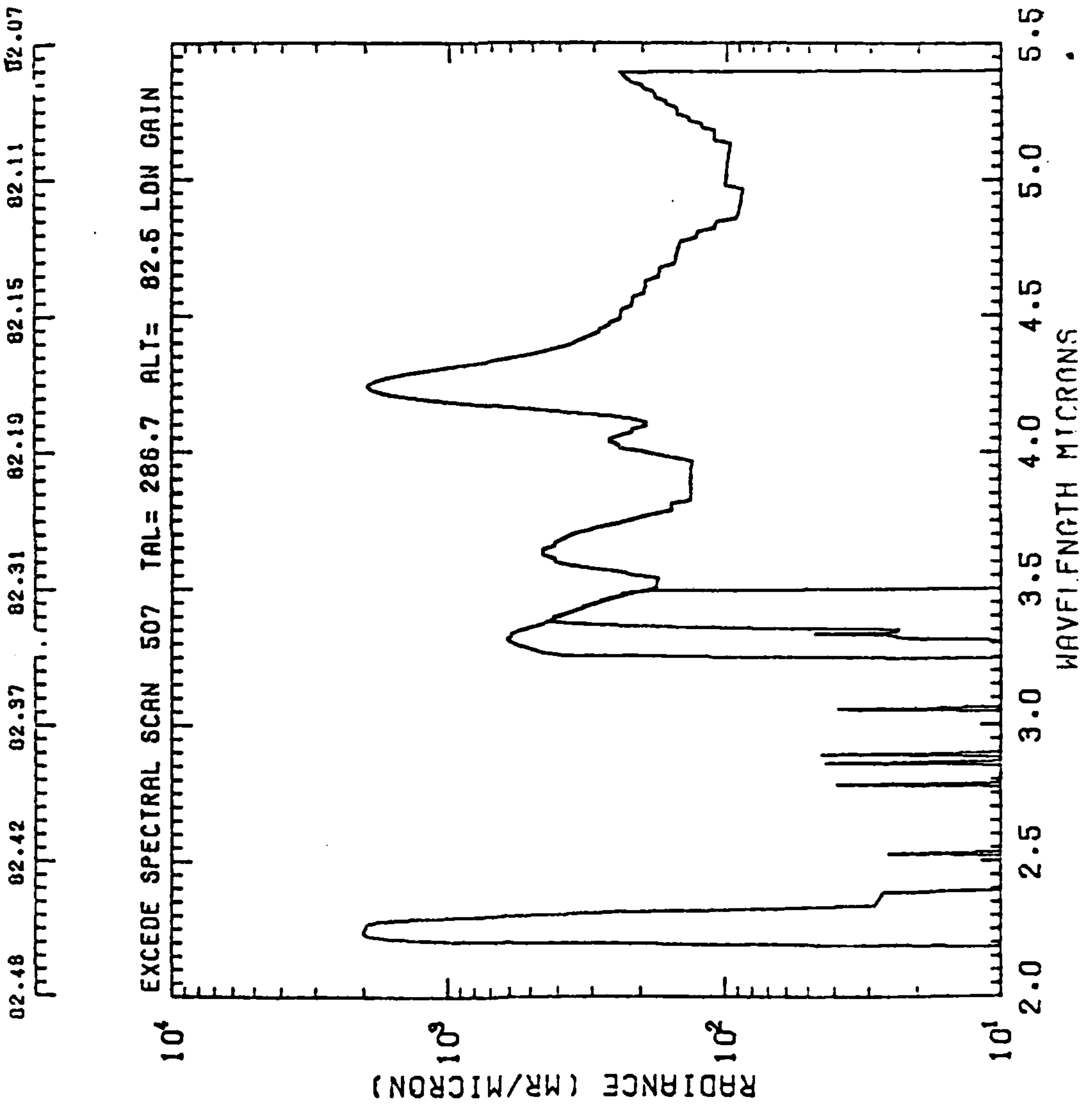
MICROCOPY RESOLUTION TEST CHART

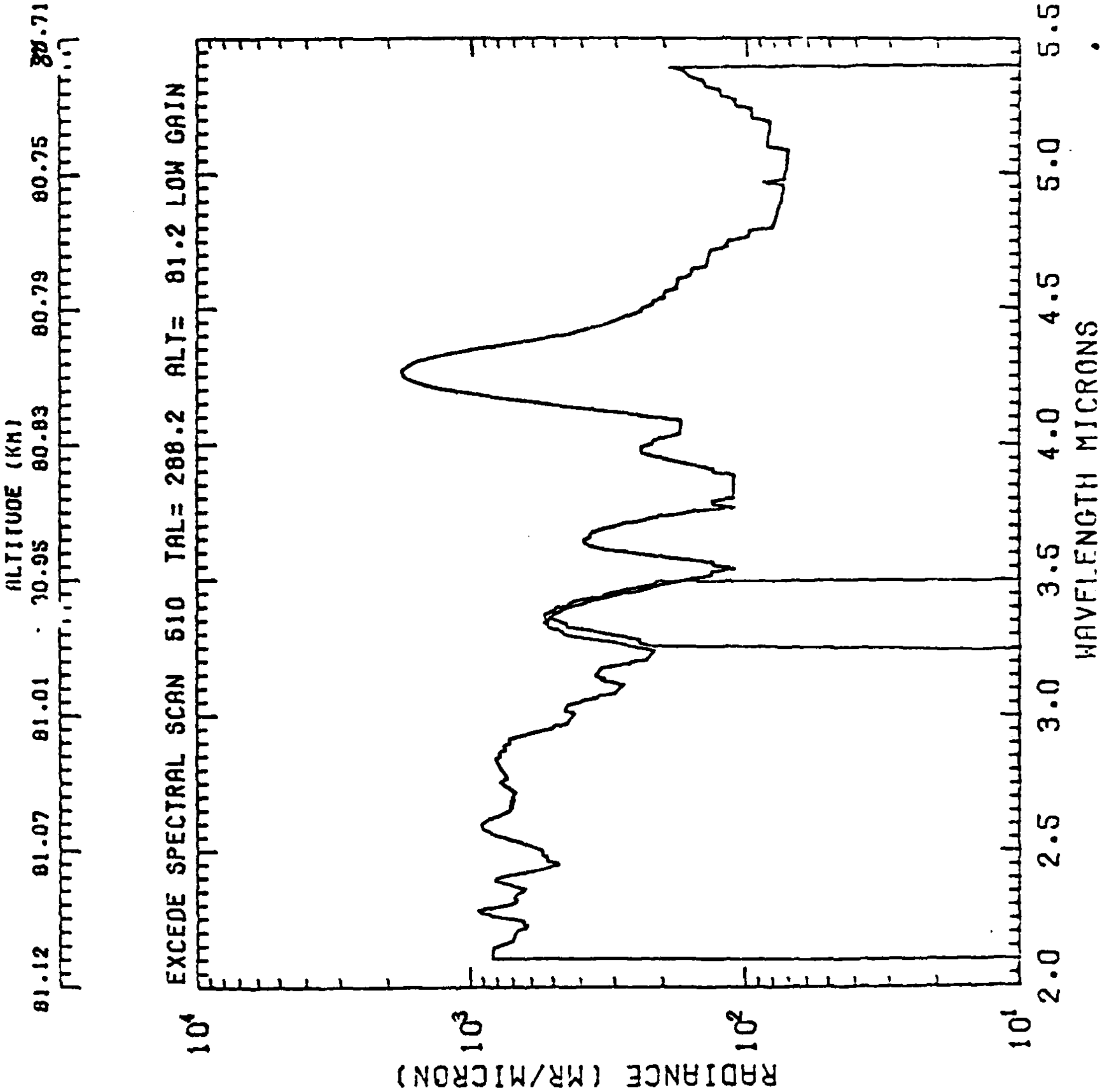
EXCEDE SPECTRAL SCAN 487 TAL= 277.0 ALT= 91.1 LOW GAIN
ALTITUDE (KM)
91.05
90.99
90.94
90.89
90.78
90.76
90.71
90.68
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

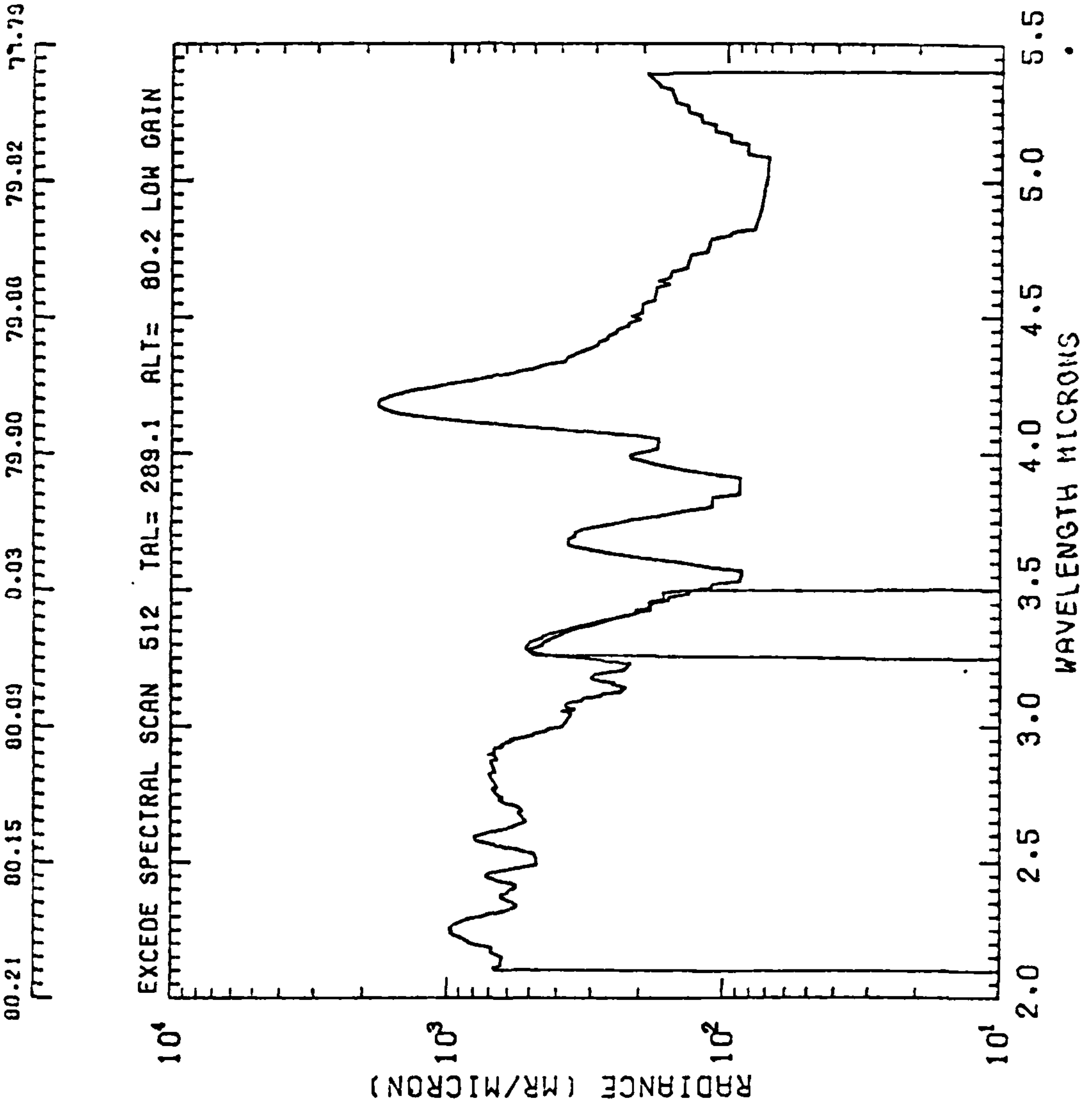

ALTITUDE (KM)
86.88
86.82
86.77
86.71
86.60
86.56
86.52
86.49
EXCEDE SPECTRAL SCAN 497 TAL= 281.9 ALT= 86.9 LOW GAIN
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

EXCEDE SPECTRAL SCAN 502 TAL= 284.3 ALT= 84.7 LOW GAIN
ALTITUDE (KM)
84.71
84.65
84.60
84.54
84.42
84.38
84.34
84.31
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5

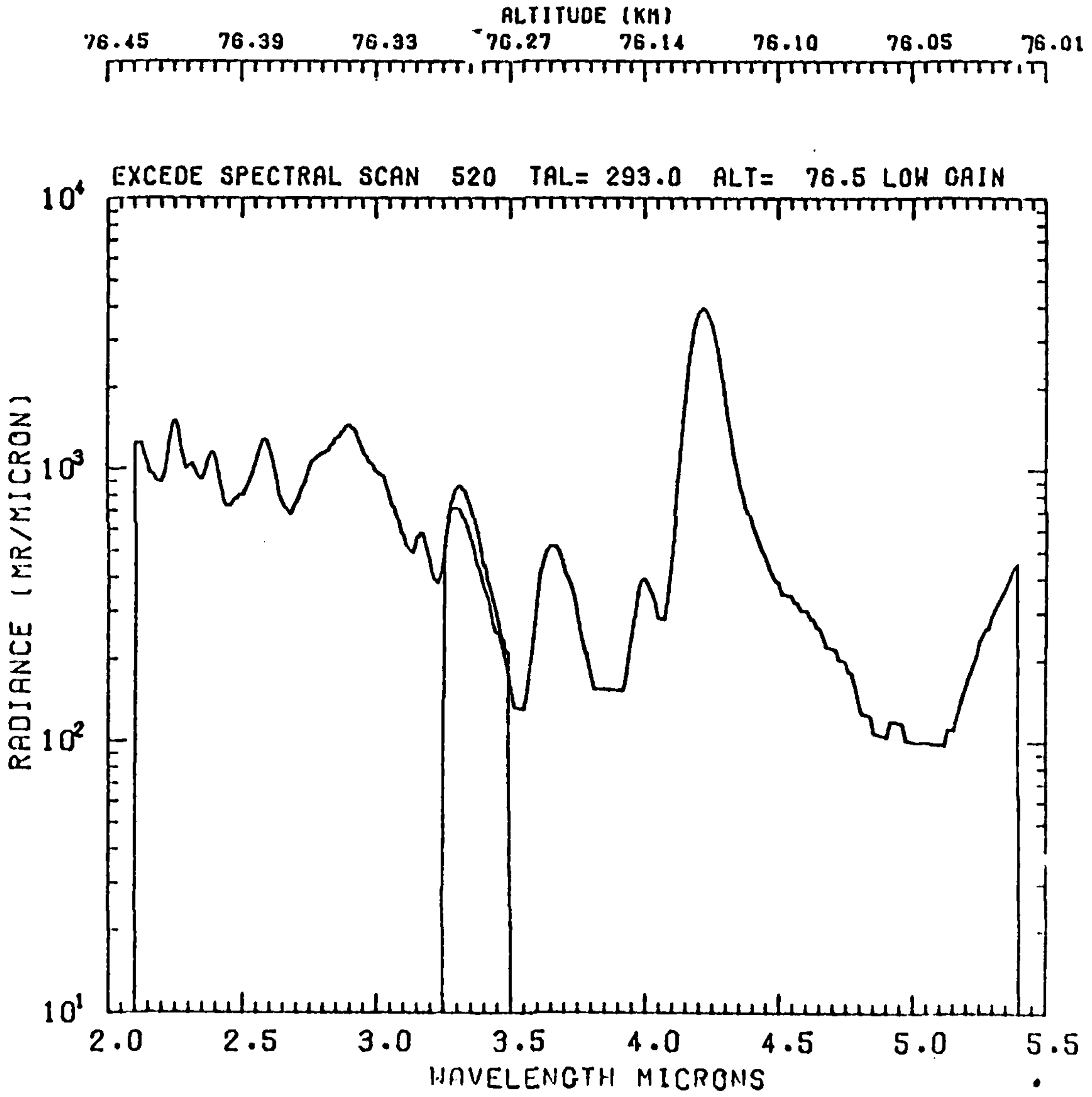

ALTITUDE (KM)
83.38
83.32
83.26
83.21
83.09
83.05
83.01
82.97
EXCEDE SPECTRAL SCAN 505 TAL= 285.7 ALT= 83.4 LOW GAIN
RADIANCE (MR/MICRON)
10^2
10^1
10^0
10^{-1}
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

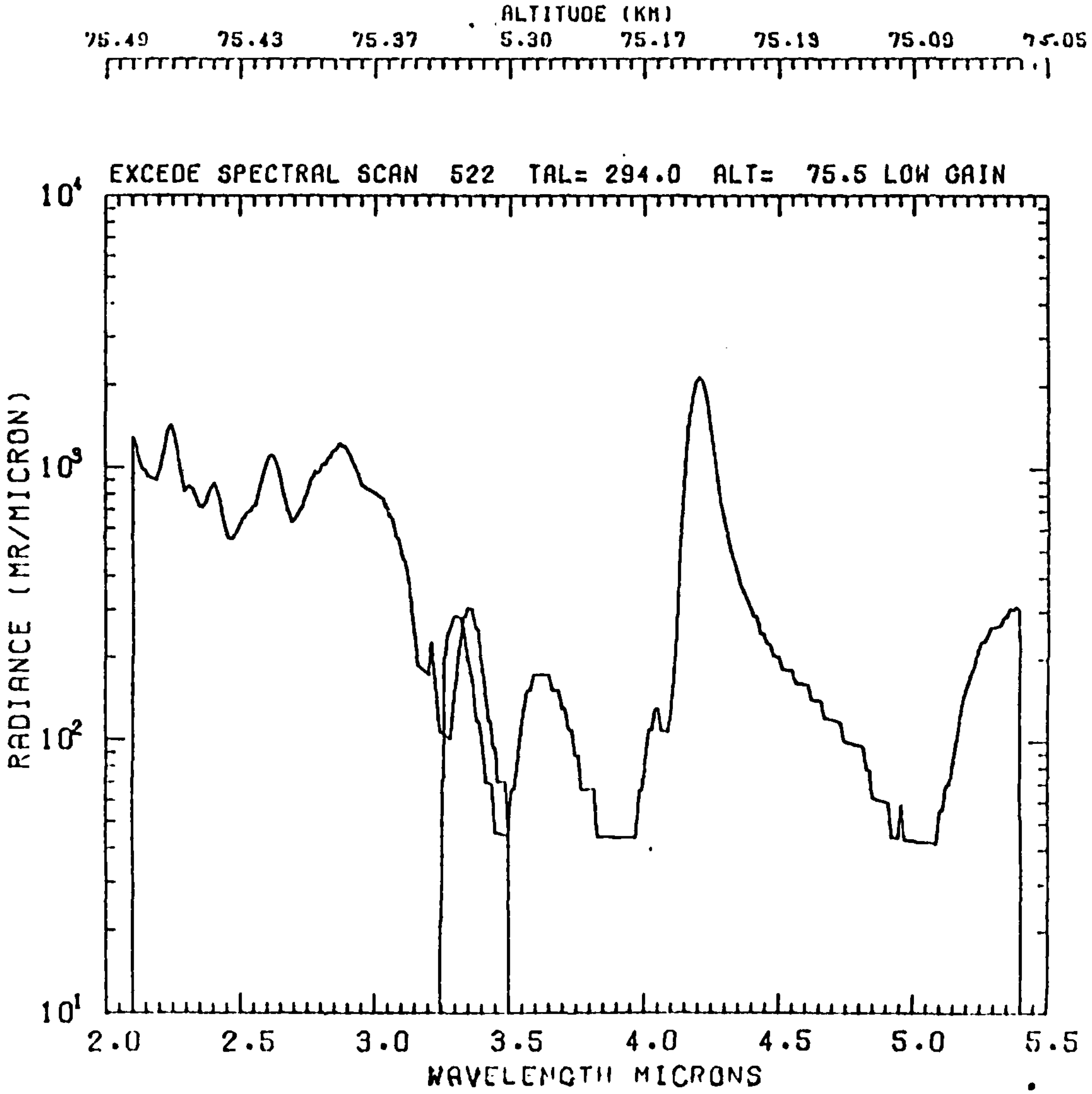

ALTITUDE (KM)
82.48
82.42
82.37
82.31
82.19
82.15
82.11
82.07
EXCEDE SPECTRAL SCAN 507 TAL= 286.7 ALT= 82.5 LOW GAIN
10^4
10^3
10^2
10^1
RADIANCE (MR/MICRON)
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS


EXCEDE SPECTRAL SCAN 510 TAL= 288.2 ALT= 81.2 LOW GAIN
ALTITUDE (KM)
81.12
81.07
81.01
80.95
80.83
80.79
80.75
80.71
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5



ALTITUDE (KM)
80.21
80.15
80.09
80.03
79.96
79.88
79.82
79.79
EXCEDE SPECTRAL SCAN 512 TAL= 289.1 ALT= 80.2 LOW GAIN
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
WAVELENGTH MICRONS
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5


ALTITUDE (KM)
76.45
76.39
76.33
76.27
76.14
76.10
76.05
76.01
EXCEDE SPECTRAL SCAN 520 TAL= 293.0 ALT= 76.5 LOW GAIN
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

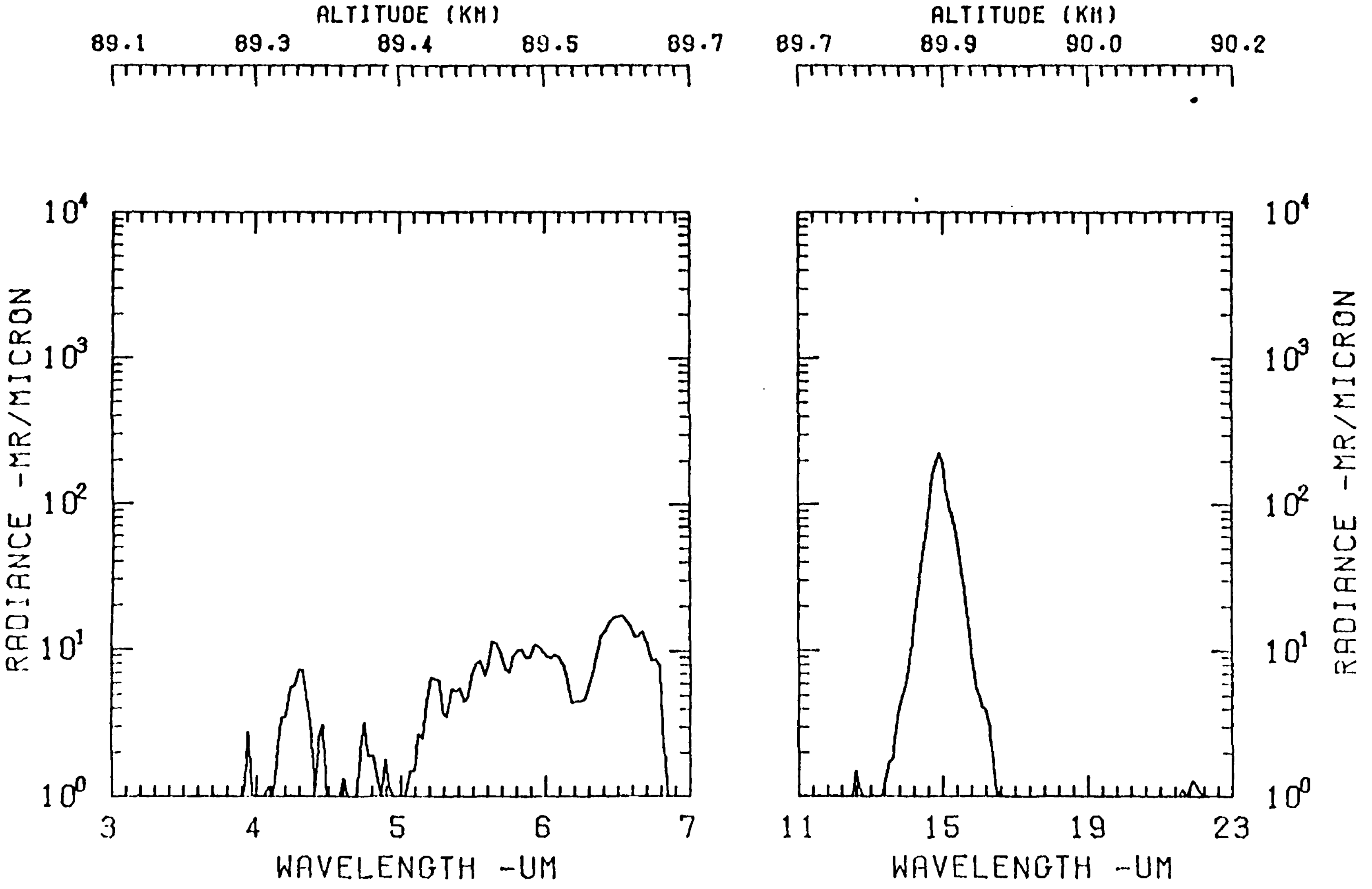

ALTITUDE (KM)
75.49
75.43
75.37
5.30
75.17
75.19
75.09
75.05
EXCEDE SPECTRAL SCAN 522 TAL= 294.0 ALT= 75.5 LOW GAIN
RADIANCE (MR/MICRON)
10^4
10^3
10^2
10^1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
WAVELENGTH MICRONS

APPENDIX E

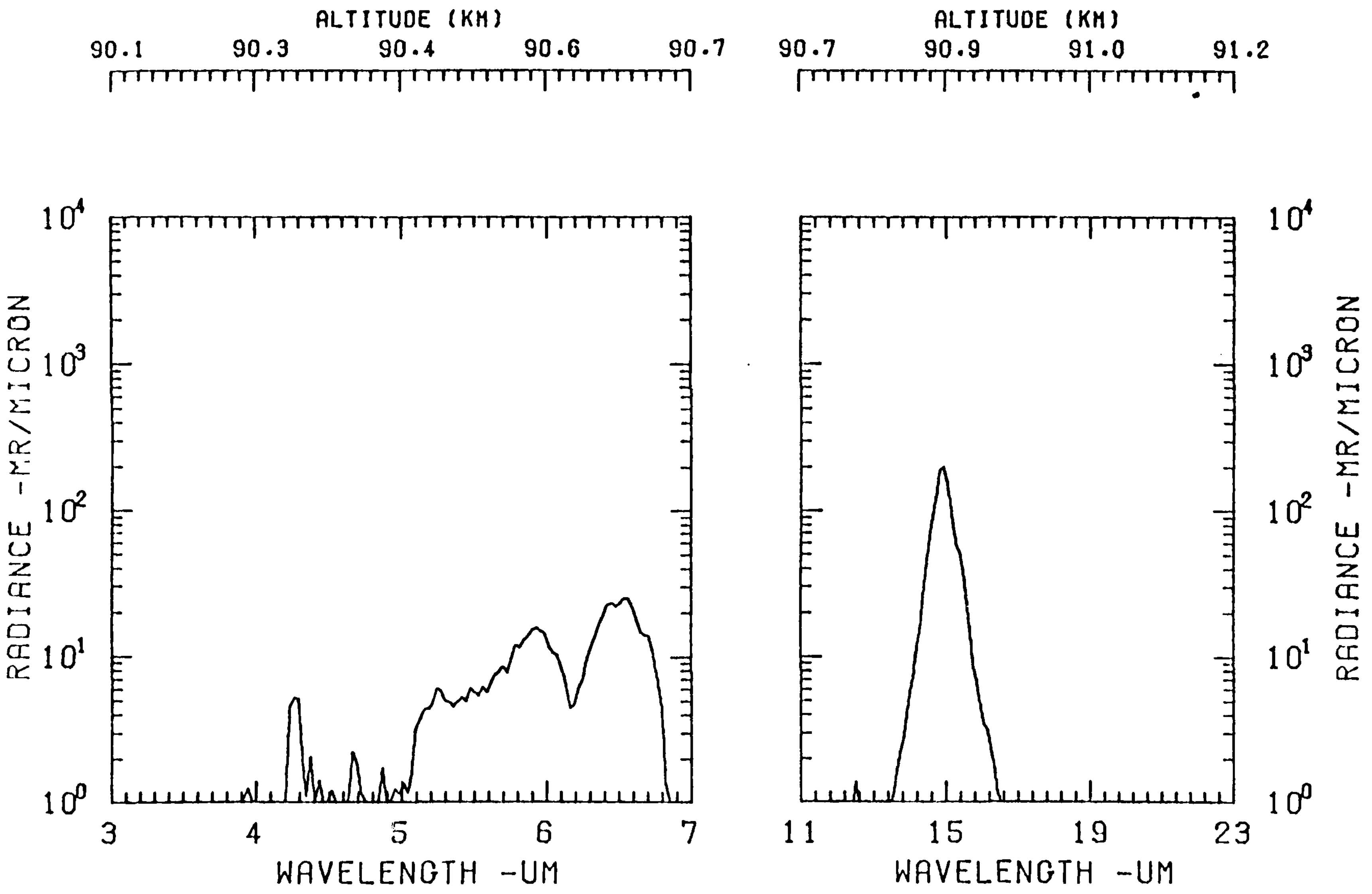
Sample Data Base for CVF HS-3B-1

This appendix contains selected spectral data developed from CVF HS-3B-1 measurements. Scans and scan start times (time after launch in seconds) follow

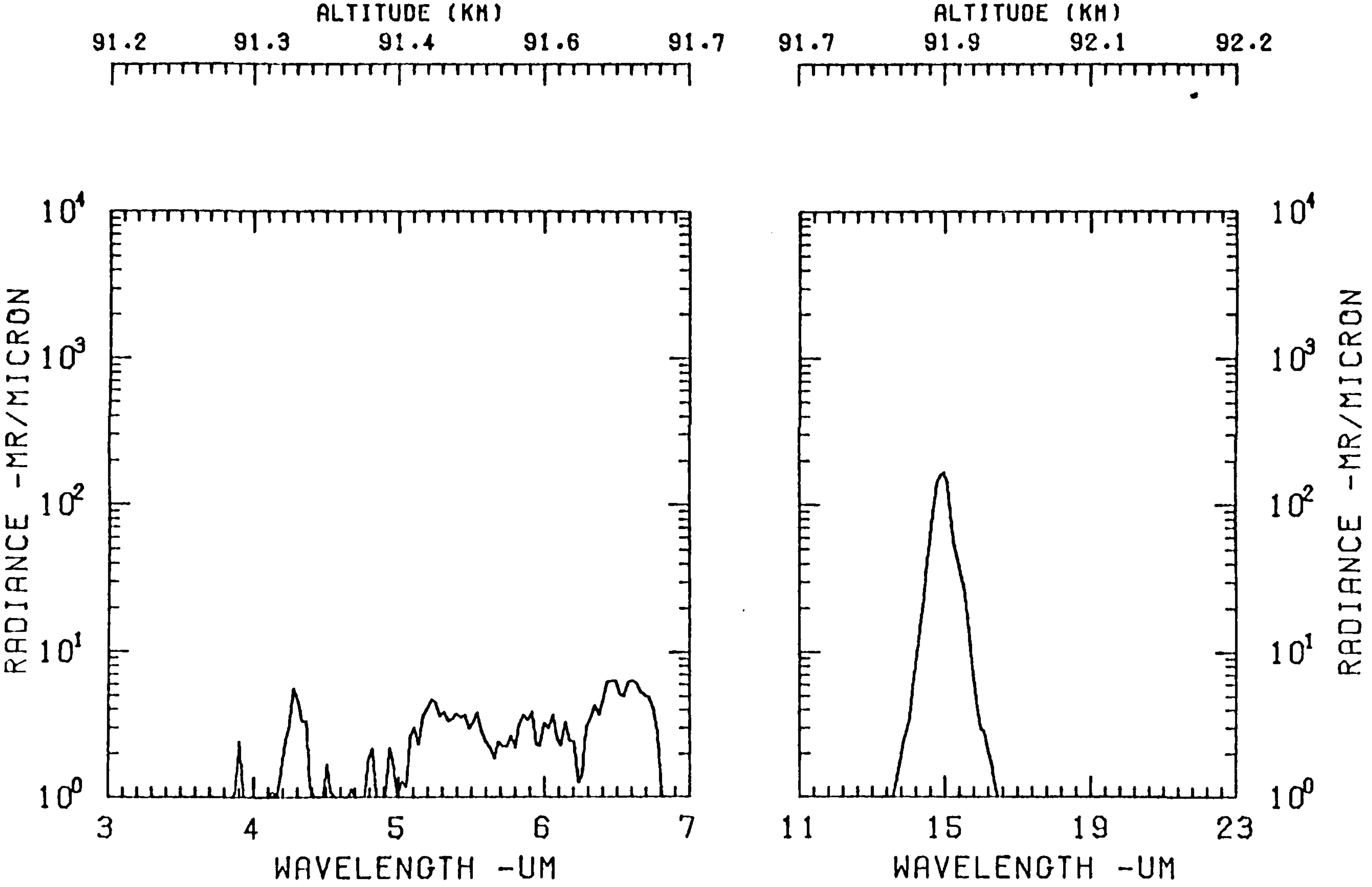
Scan	T.A.L.	Scan	T.A.L.
1047	96.1650	1111	173.7760
1048	97.3730	1159	232.9600
1049	98.5790	1171	246.9950
1051	100.9930	1180	257.8540
1055	105.8200	1188	267.5050
1056	107.0260	1196	277.1560
1062	114.2680	1200	281.9820
1063	115.4730	1202	284.3940
1064	116.6810	1203	285.6000
1069	122.7150	1204	286.8070
1070	123.9220	1205	288.0130
1073	127.5420	1206	289.2200
1090	148.0560	1209	292.8380
1092	150.4700	1210	294.0450
1093	151.6770	1211	295.251
1095	154.0910		
1109	171.3120		



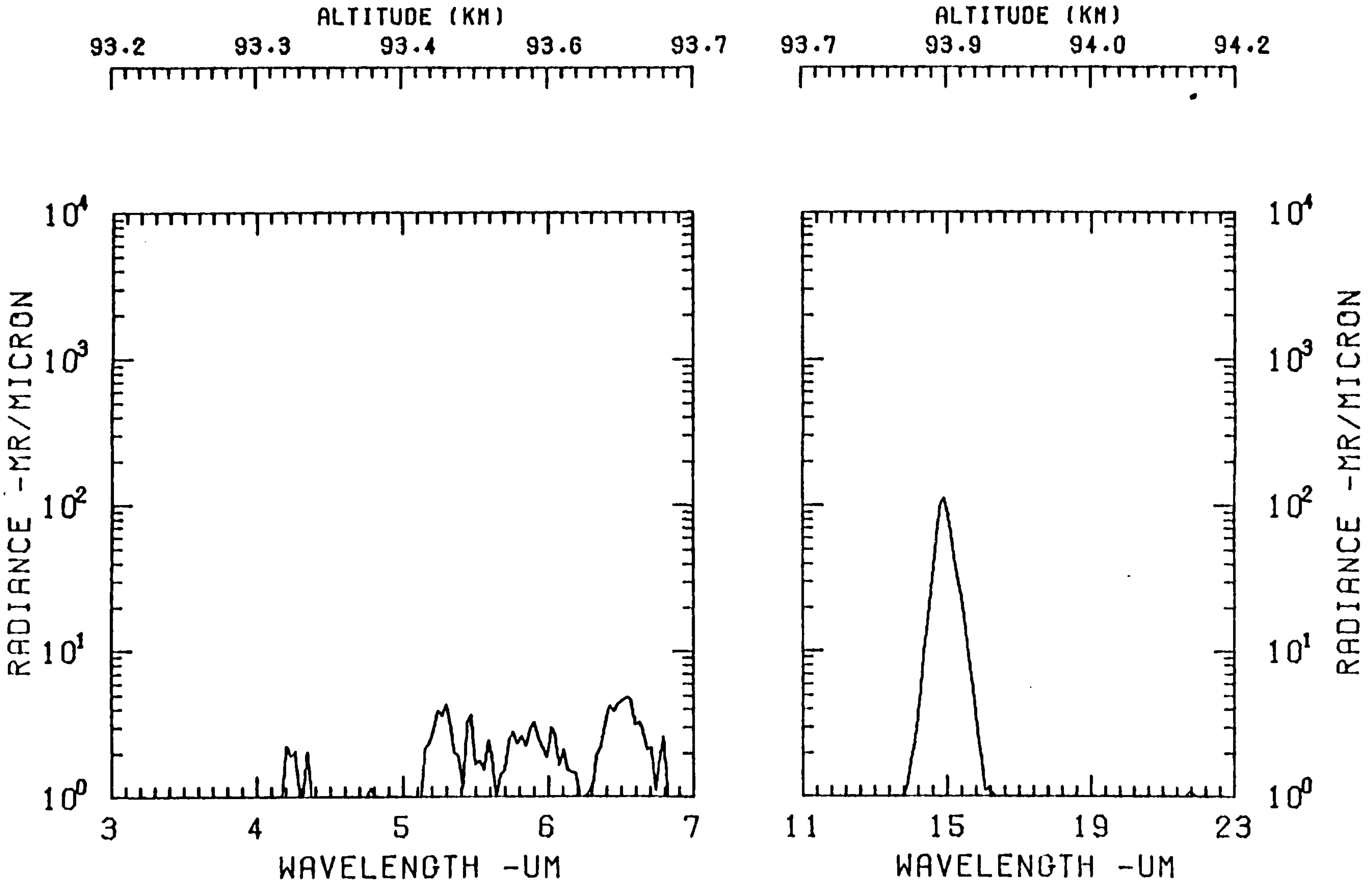
EXCEDE SPECTRAL SCAN 1047 TAL= 96.2 ALT= 89.2 ALL GAIN CAL. 53



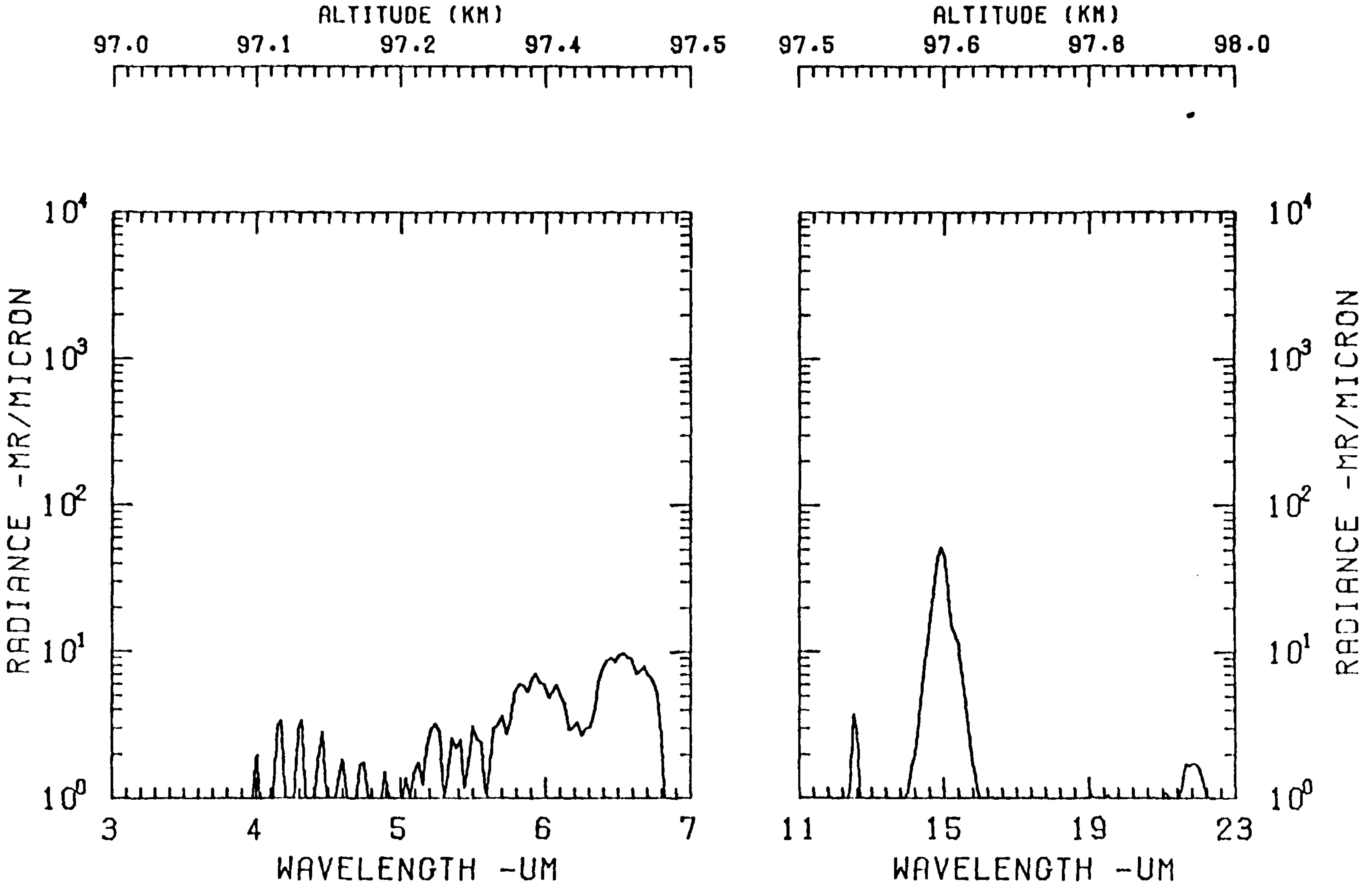
EXCEDE SPECTRAL SCAN 1048 TAL= 97.4 ALT= 90.2 ALL GAIN CAL. 53



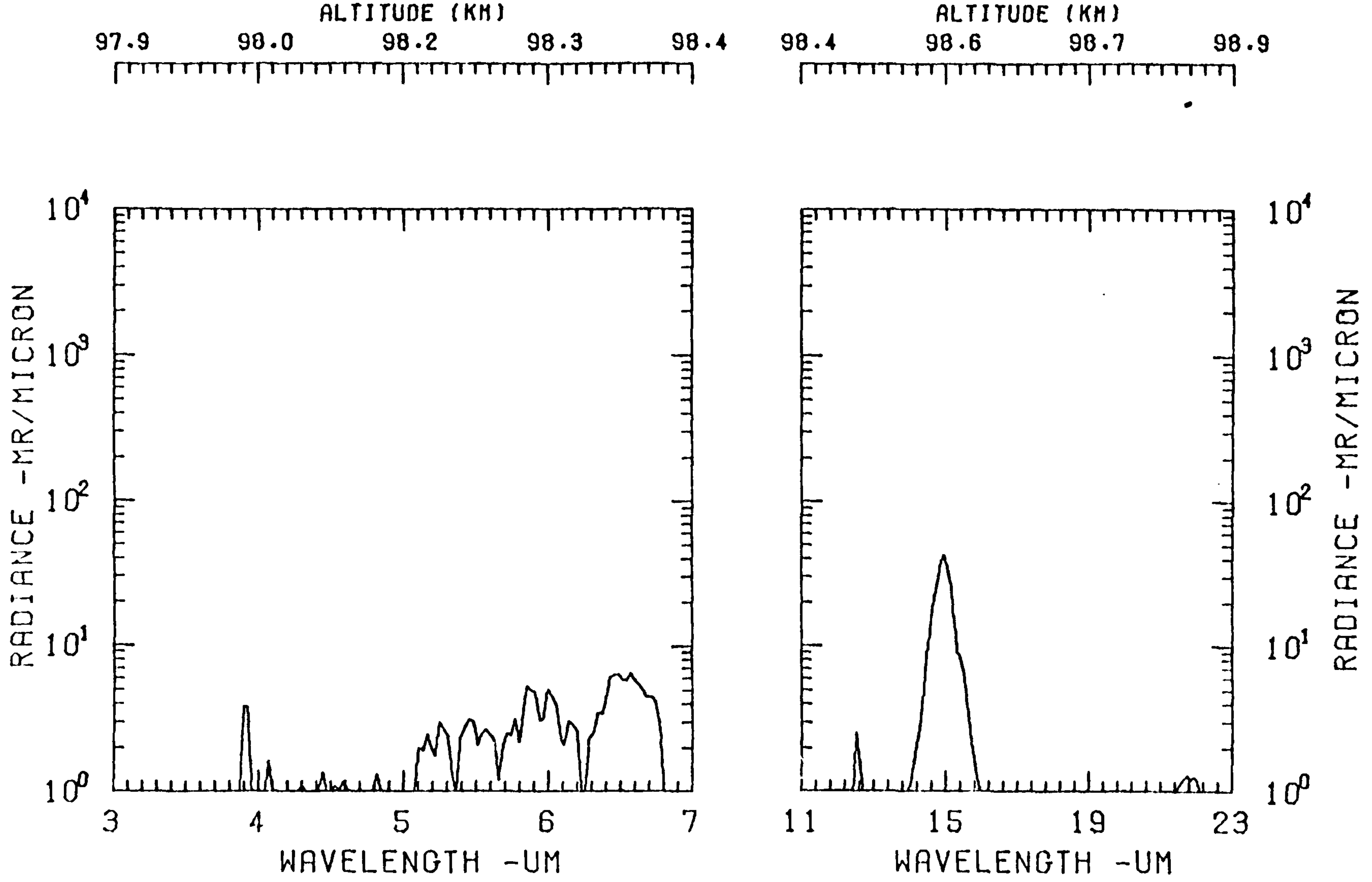
EXCEDE SPECTRAL SCAN 1049 TAL= 98.6 ALT= 91.2 ALL GAIN CAL. 53



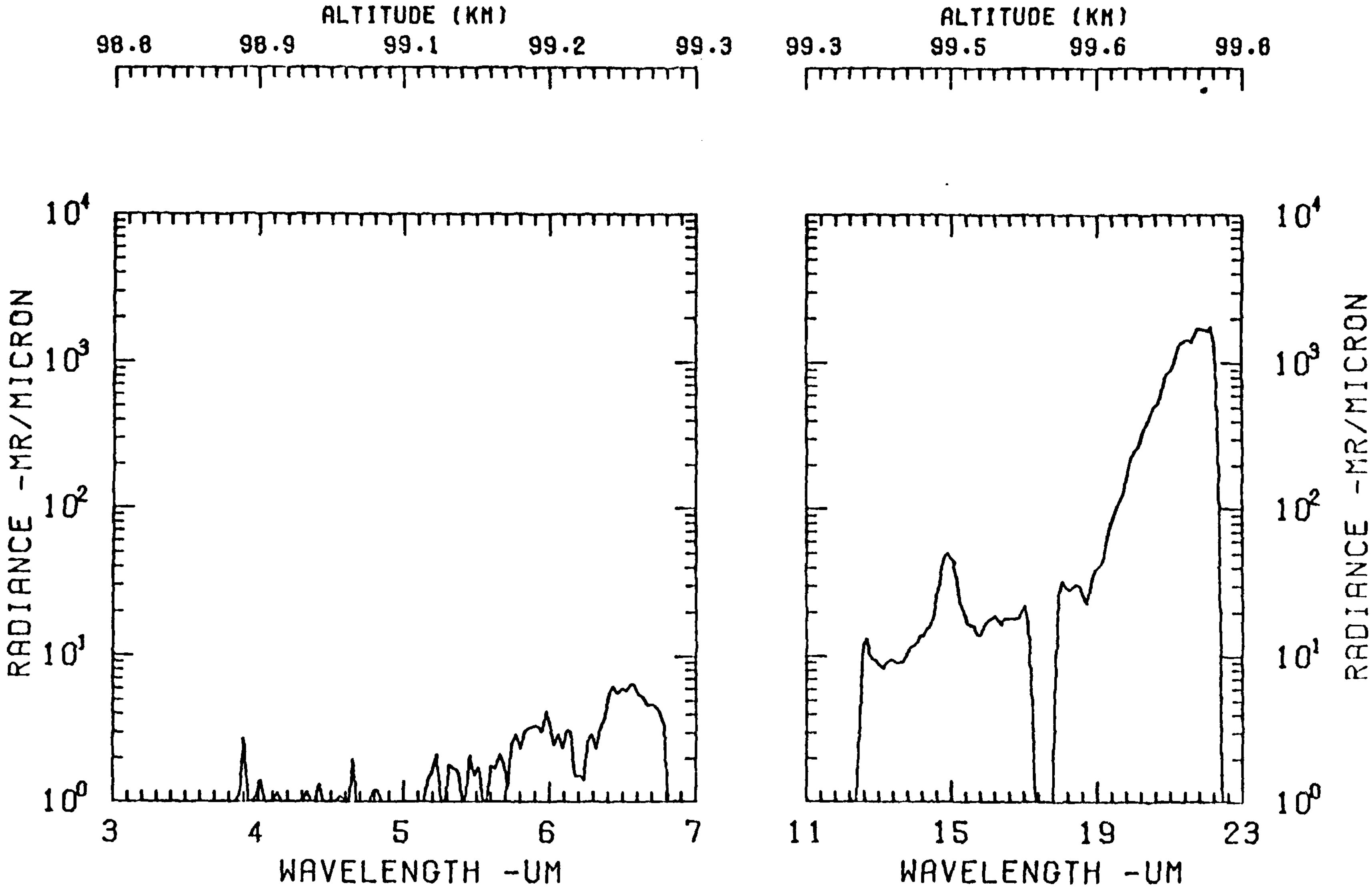
EXCEDE SPECTRAL SCAN 1051 TAL= 101.0 ALT= 93.2 ALL GAIN CAL. 53



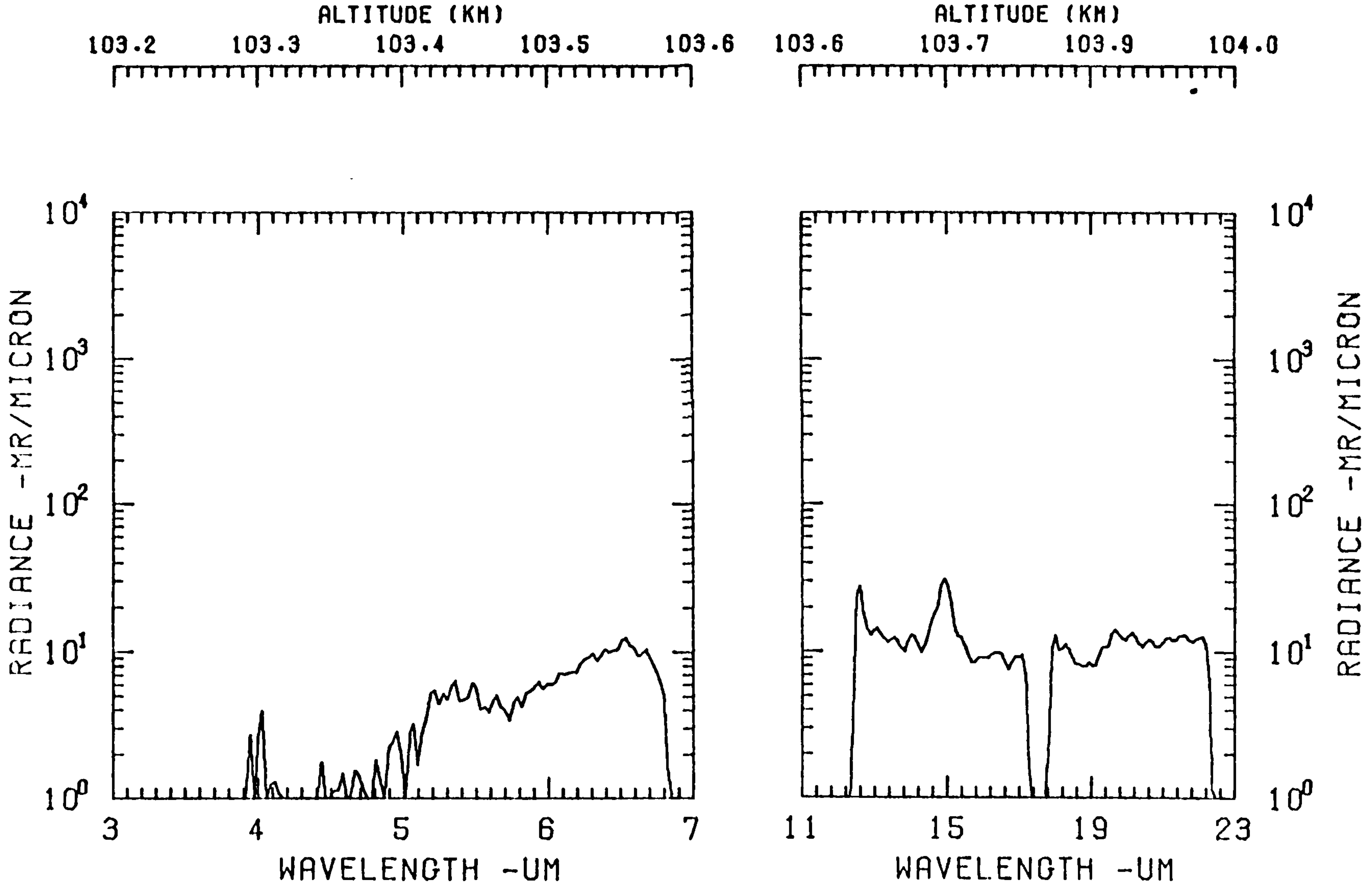
EXCEDE SPECTRAL SCAN 1055 TAL= 105.8 ALT= 97.0 ALL GAIN CAL. 53



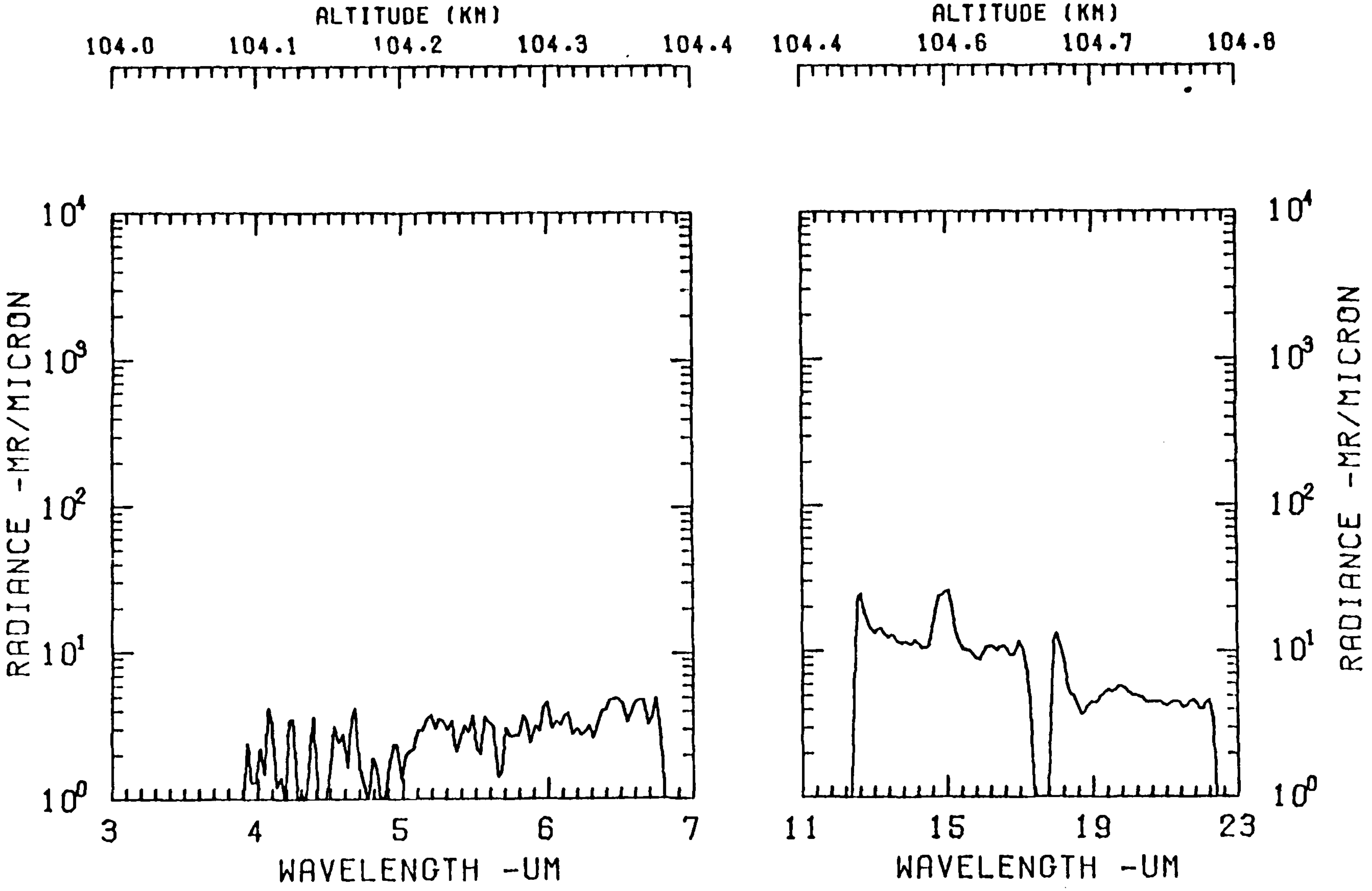
EXCEDE SPECTRAL SCAN 1056 TAL= 107.0 ALT= 98.0 ALL GAIN CAL. 53



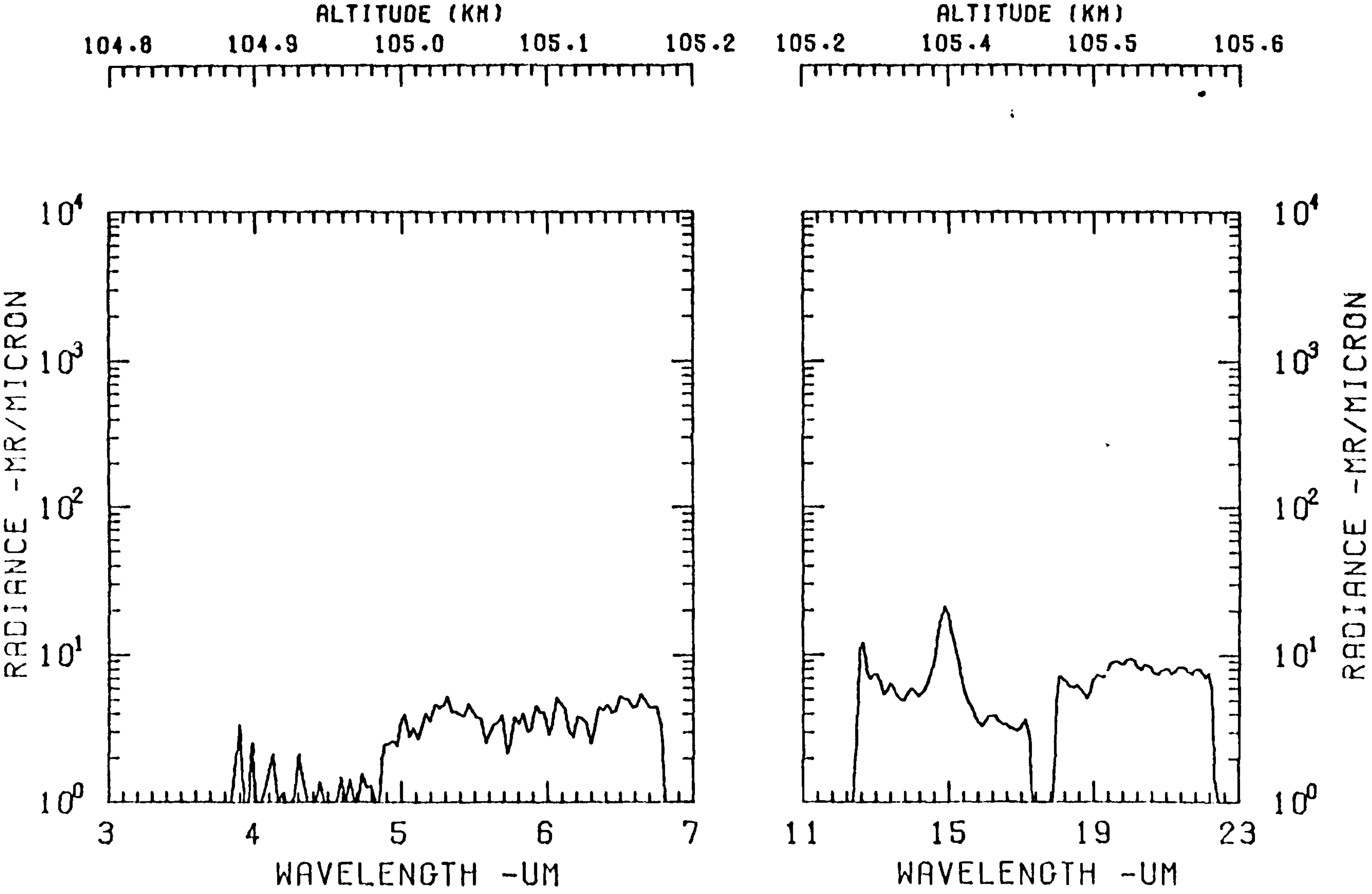
EXCEDE SPECTRAL SCAN 1057 TAL= 108.2 ALT= 98.9 ALL GAIN CAL. 53



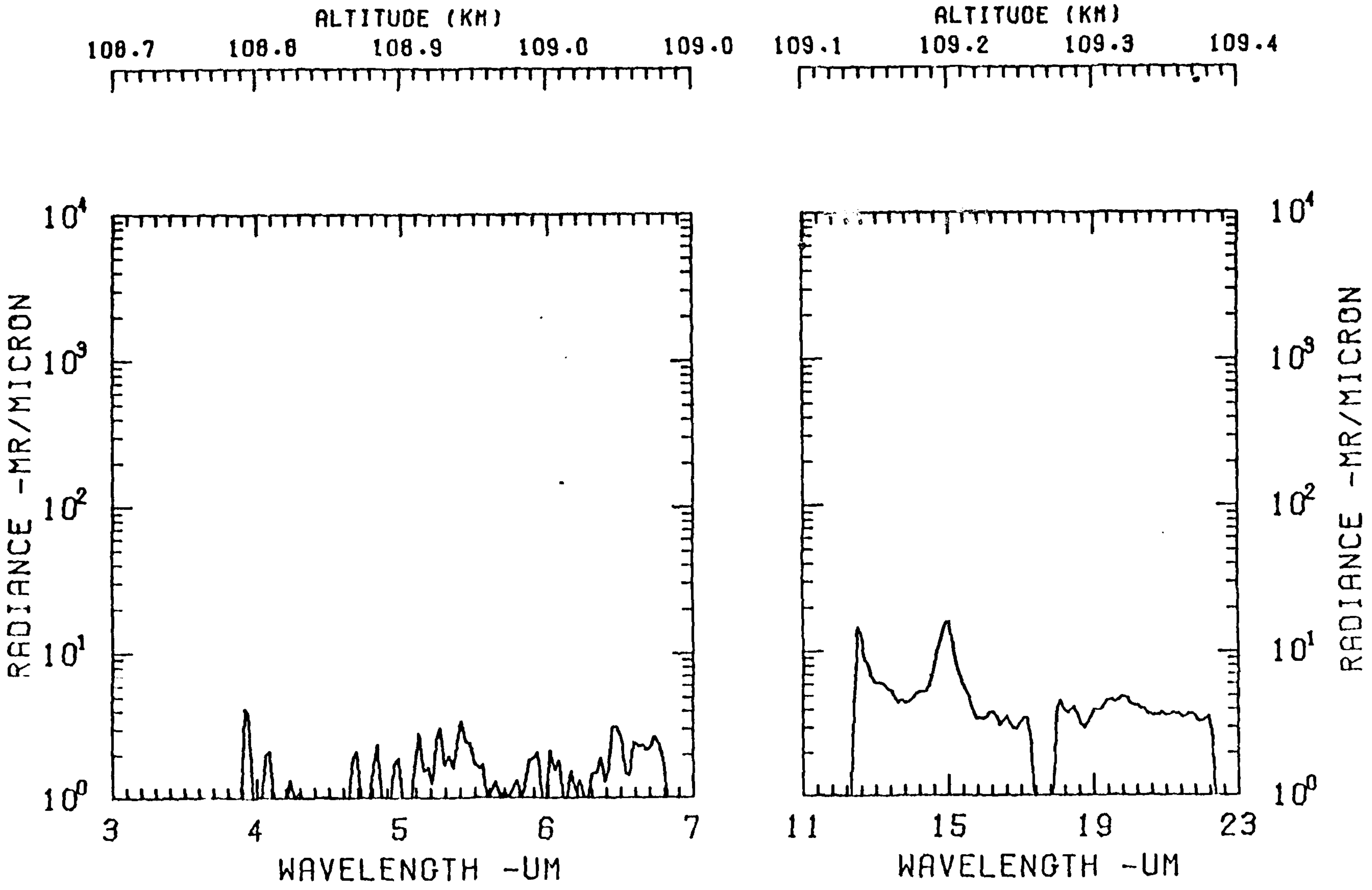
EXCEDE SPECTRAL SCAN 1062 TAL= 114.3 ALT= 103.2 ALL GAIN CAL. 53



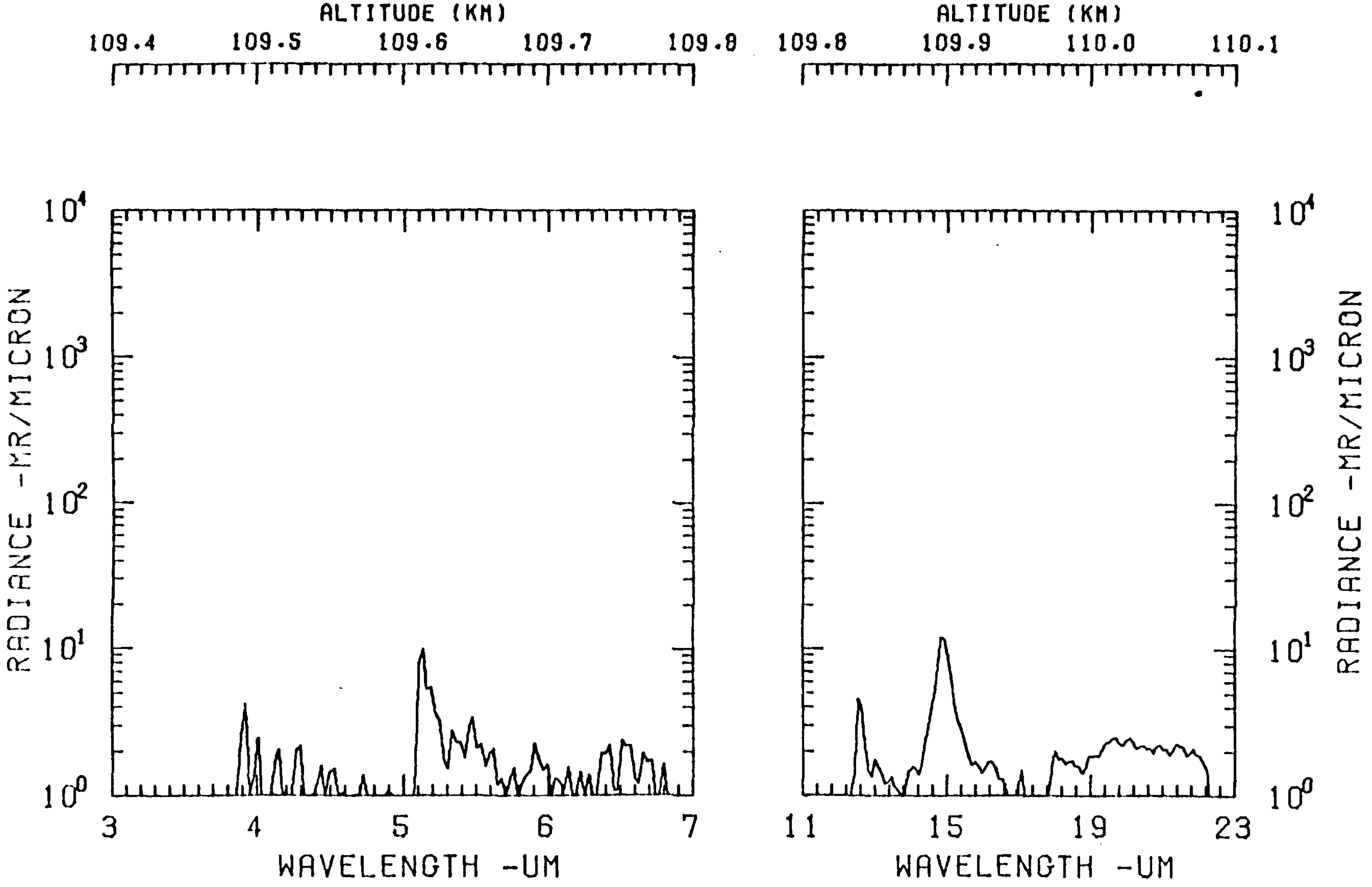
EXCEDE SPECTRAL SCAN 1063 TAL= 115.5 ALT= 104.0 ALL GAIN CAL. 53



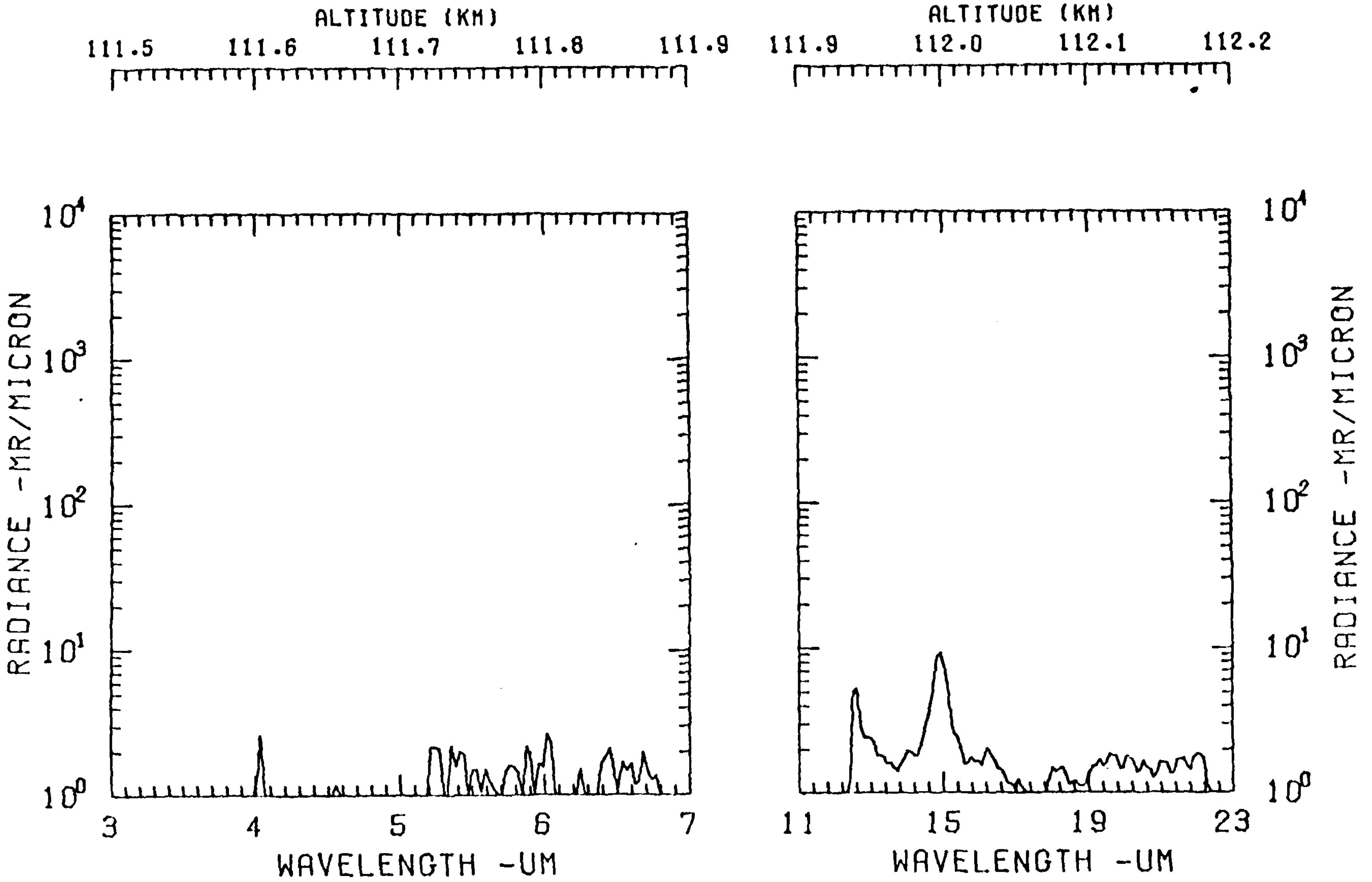
EXCEDE SPECTRAL SCAN 1064 TAL= 116.7 ALT= 104.8 ALL GAIN CAL. 53



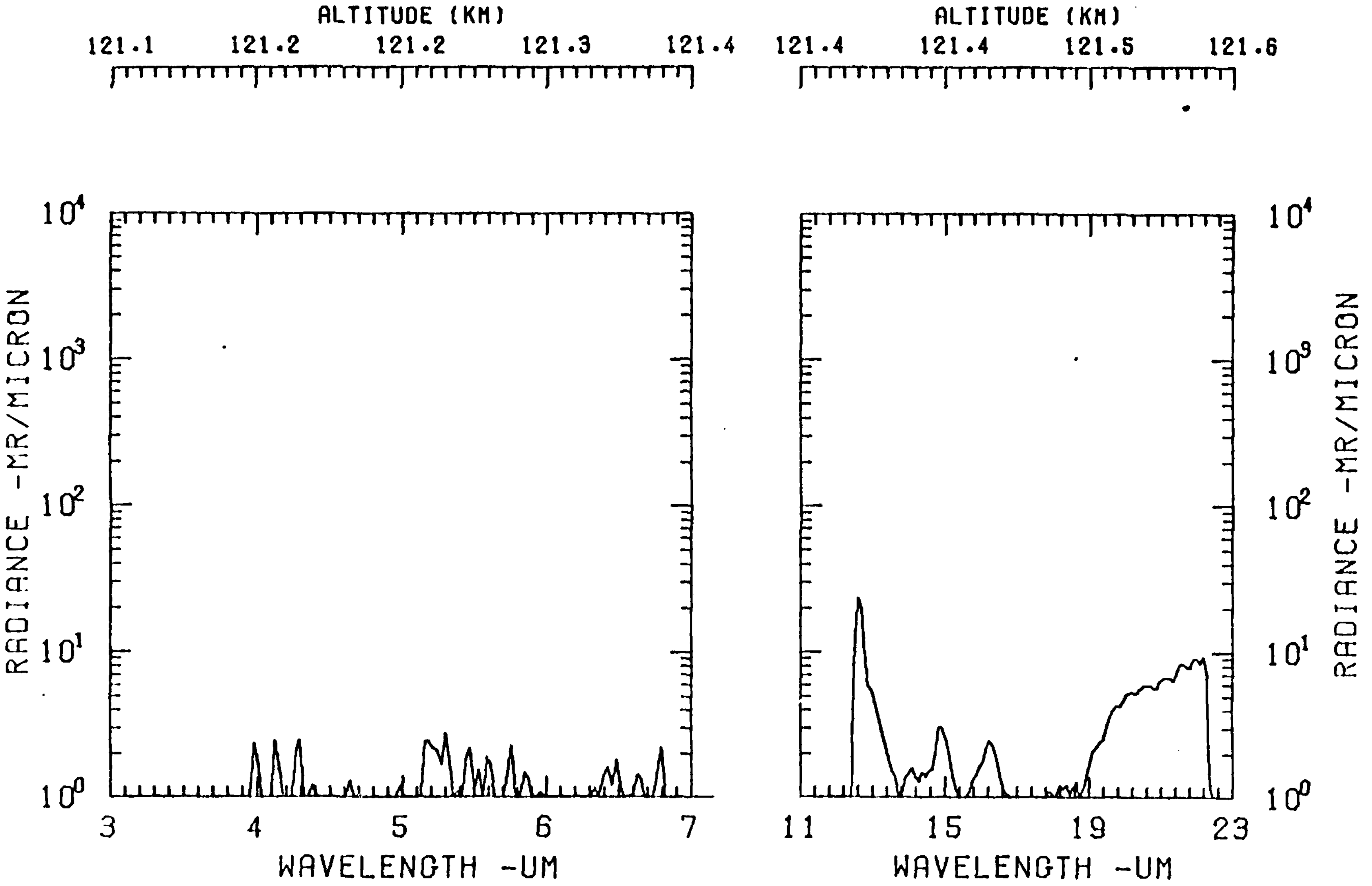
EXCEDE SPECTRAL SCAN 1069 TAL= 122.7 ALT= 108.7 ALL GAIN CAL. 53



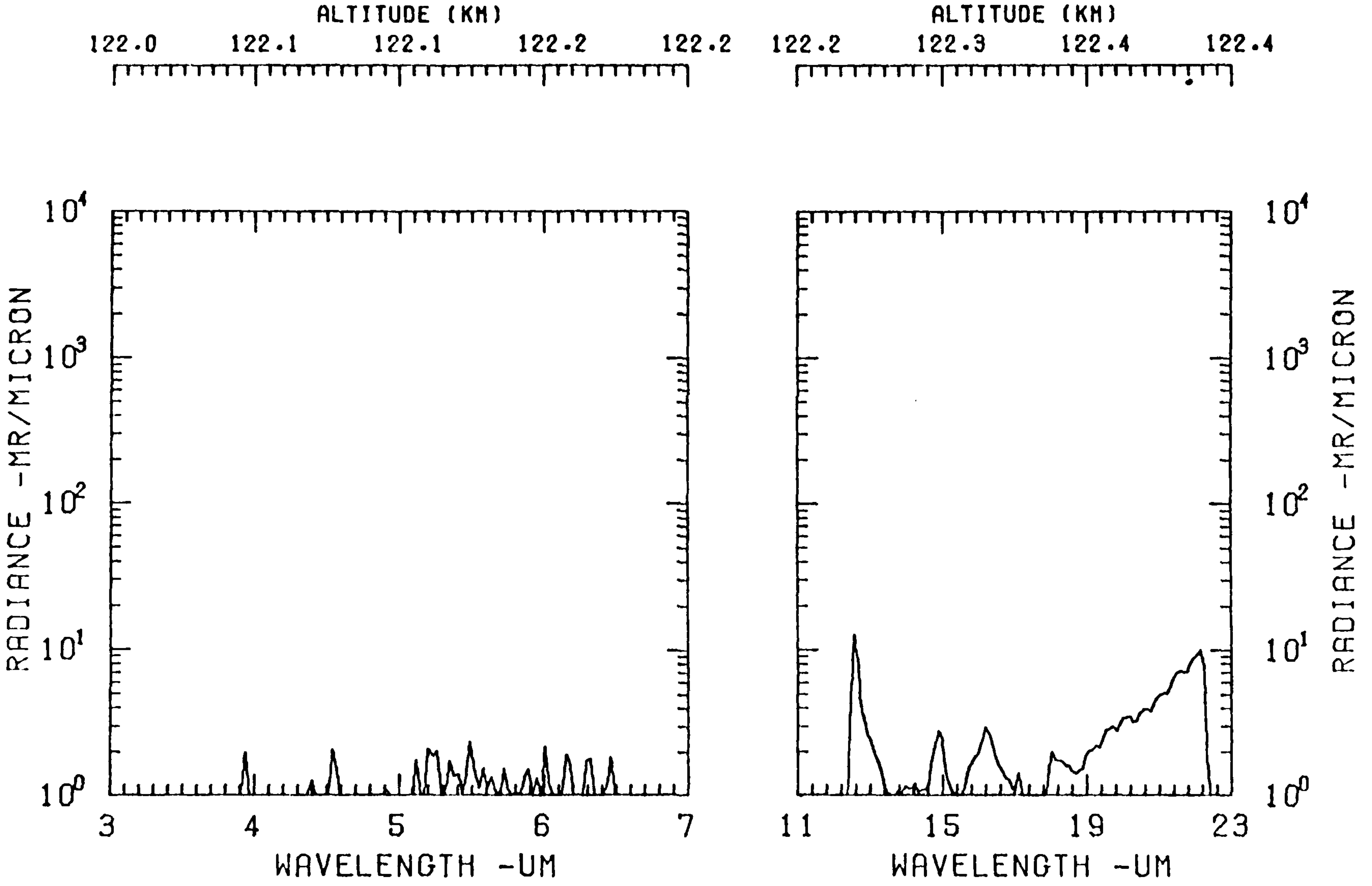
EXCEDE SPECTRAL SCAN 1070 TAL= 123.9 ALT= 109.4 ALL GAIN CAL. 53



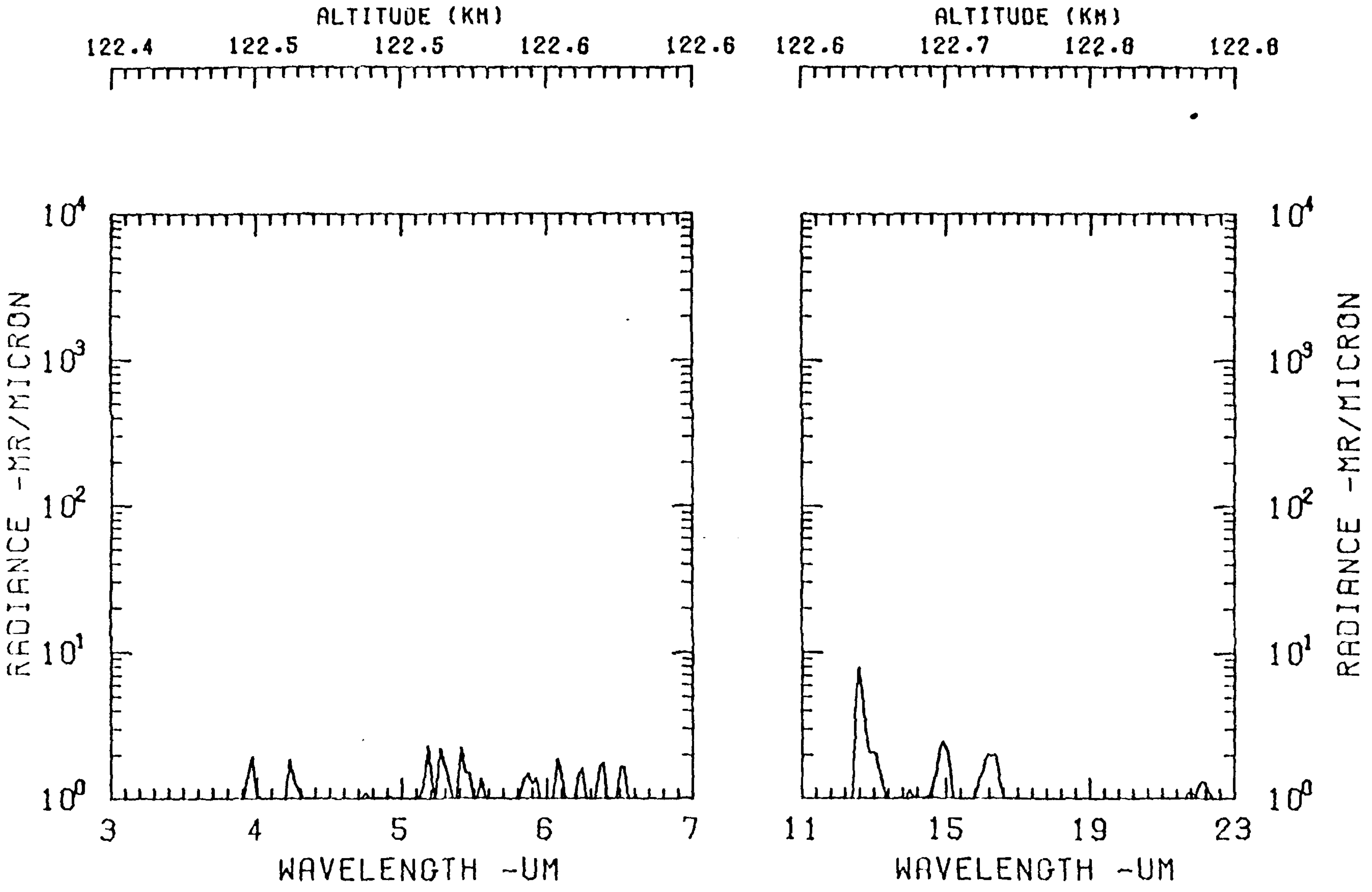
EXCEDE SPECTRAL SCAN 1073 TAL= 127.5 ALT= 111.5 ALL GAIN CAL. 53



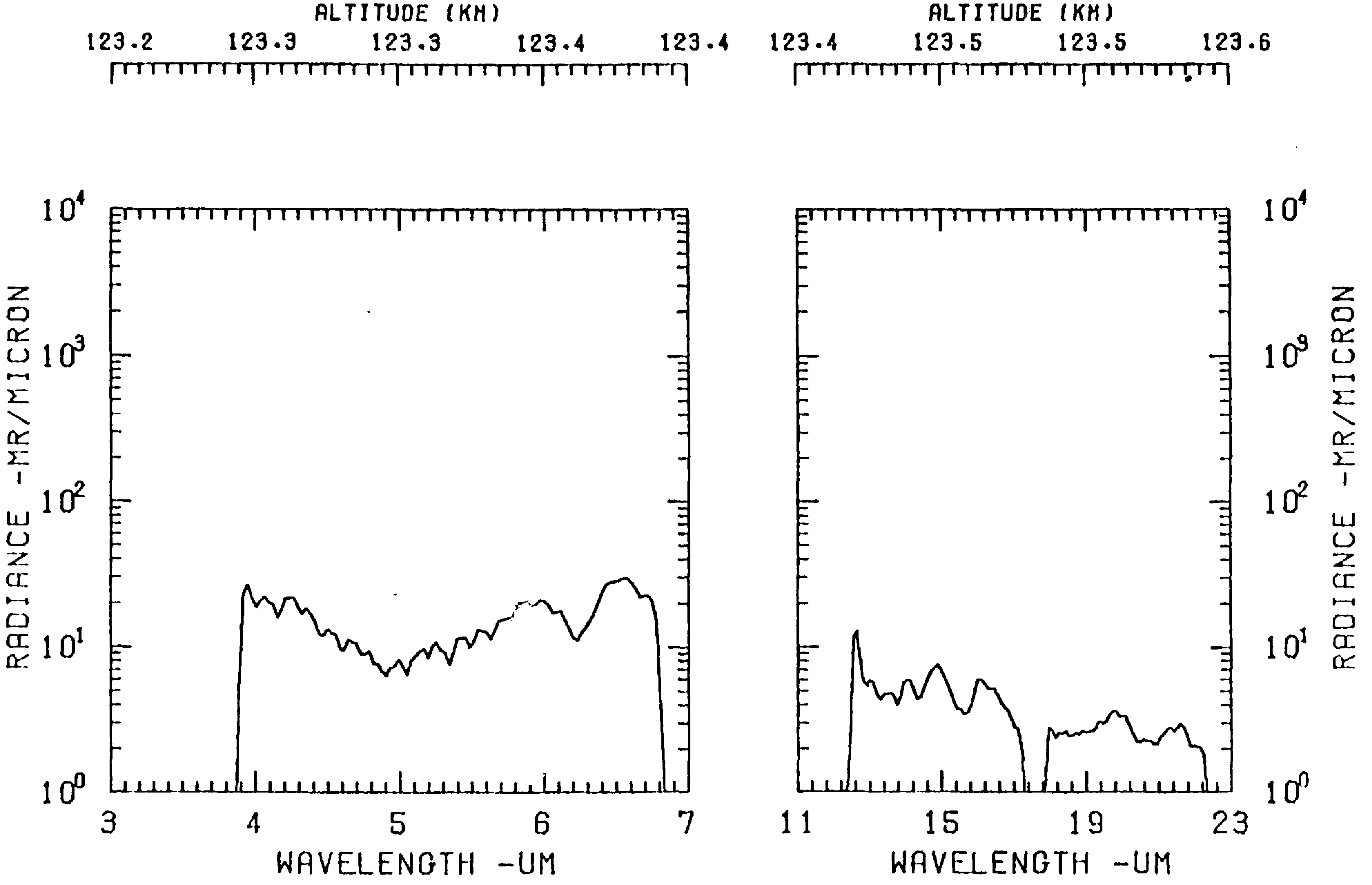
EXCEDE SPECTRAL SCAN 1090 TAL= 148.1 ALT= 121.1 ALL GAIN CAL. 53



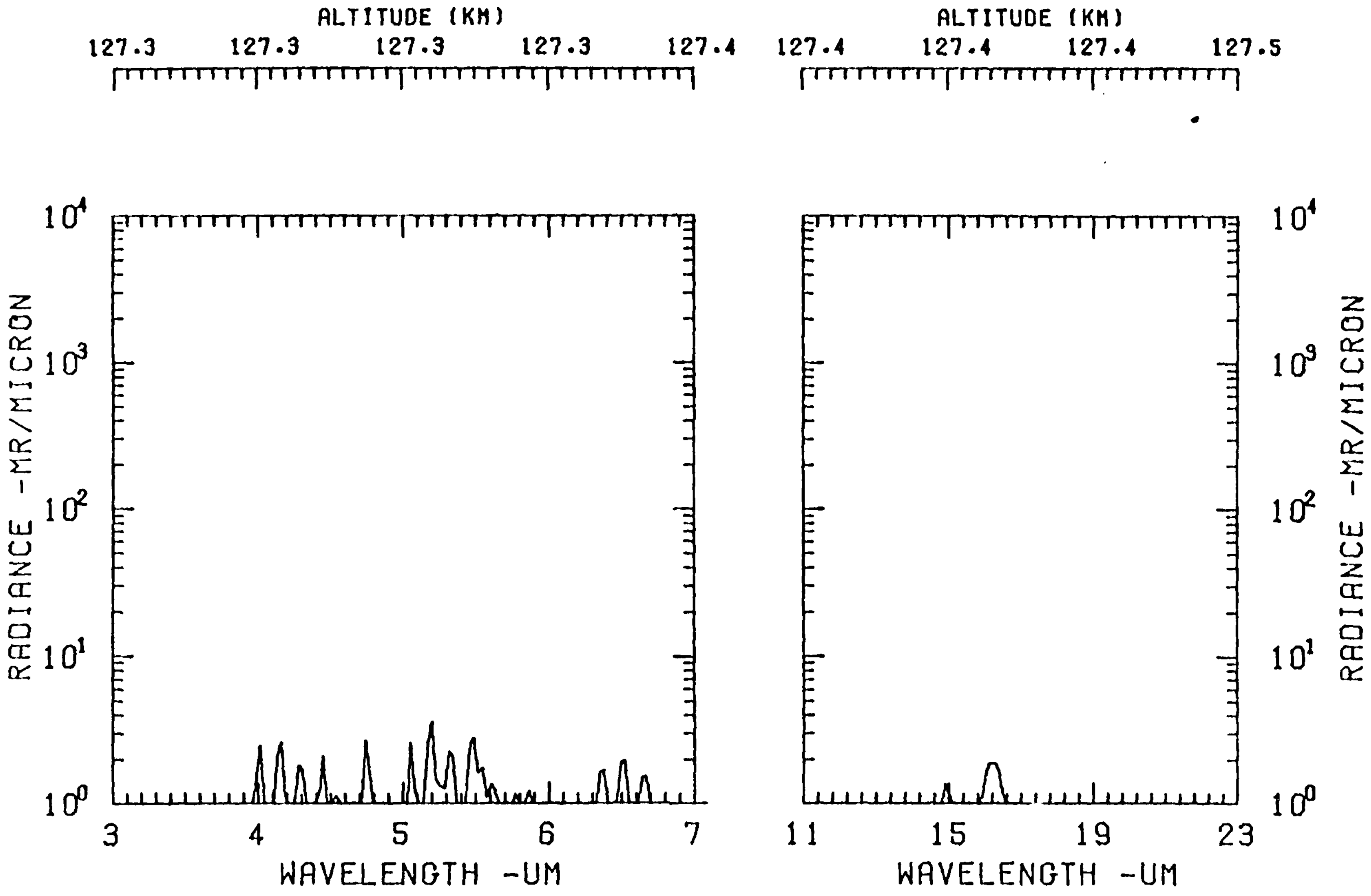
EXCEDE SPECTRAL SCAN 1092 TAL= 150.5 ALT= 122.0 ALL GAIN CAL. 53



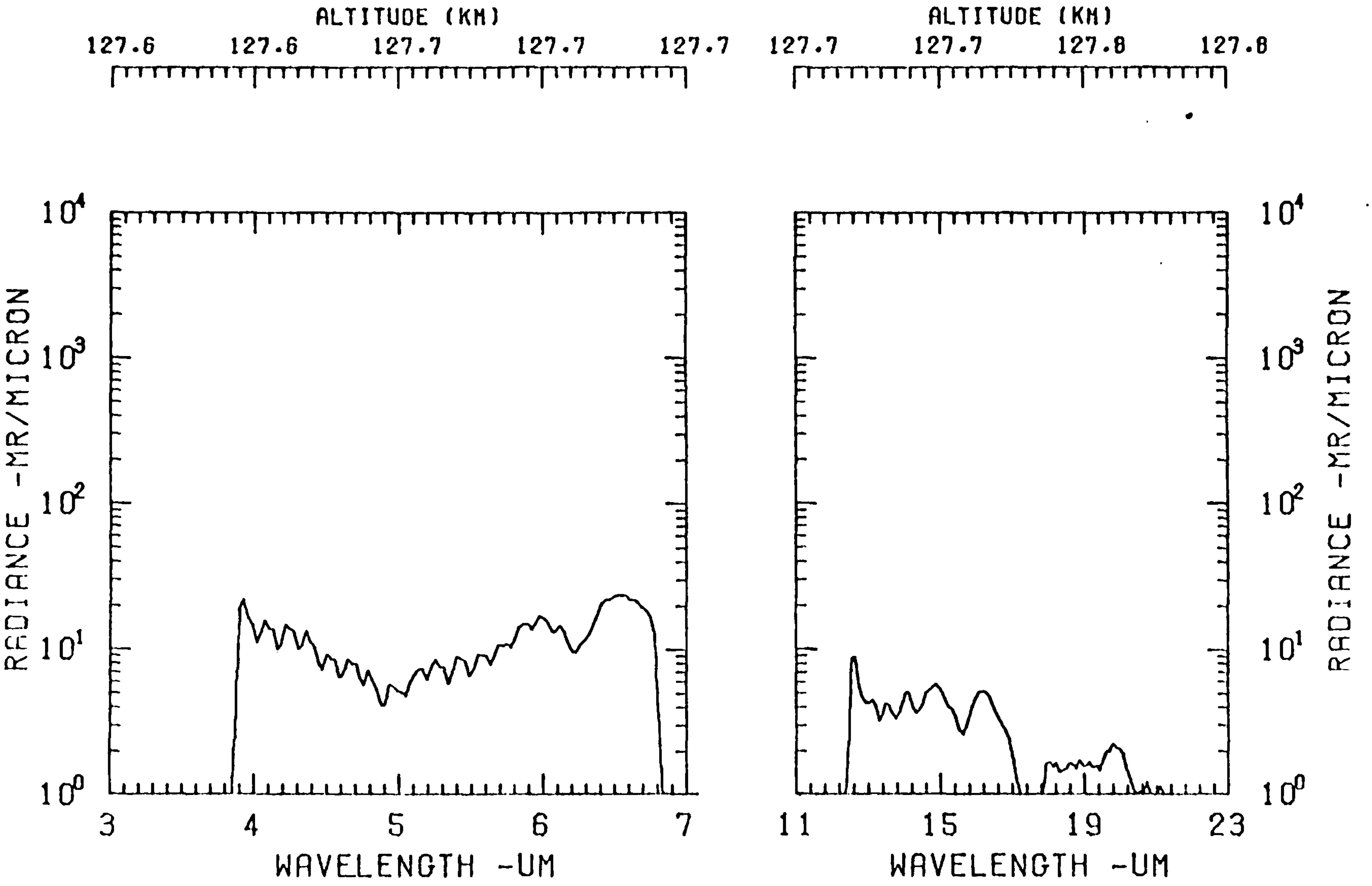
EXCEDE SPECTRAL SCAN 1093 TAL= 151.7 ALT= 122.4 ALL GAIN CAL. 53



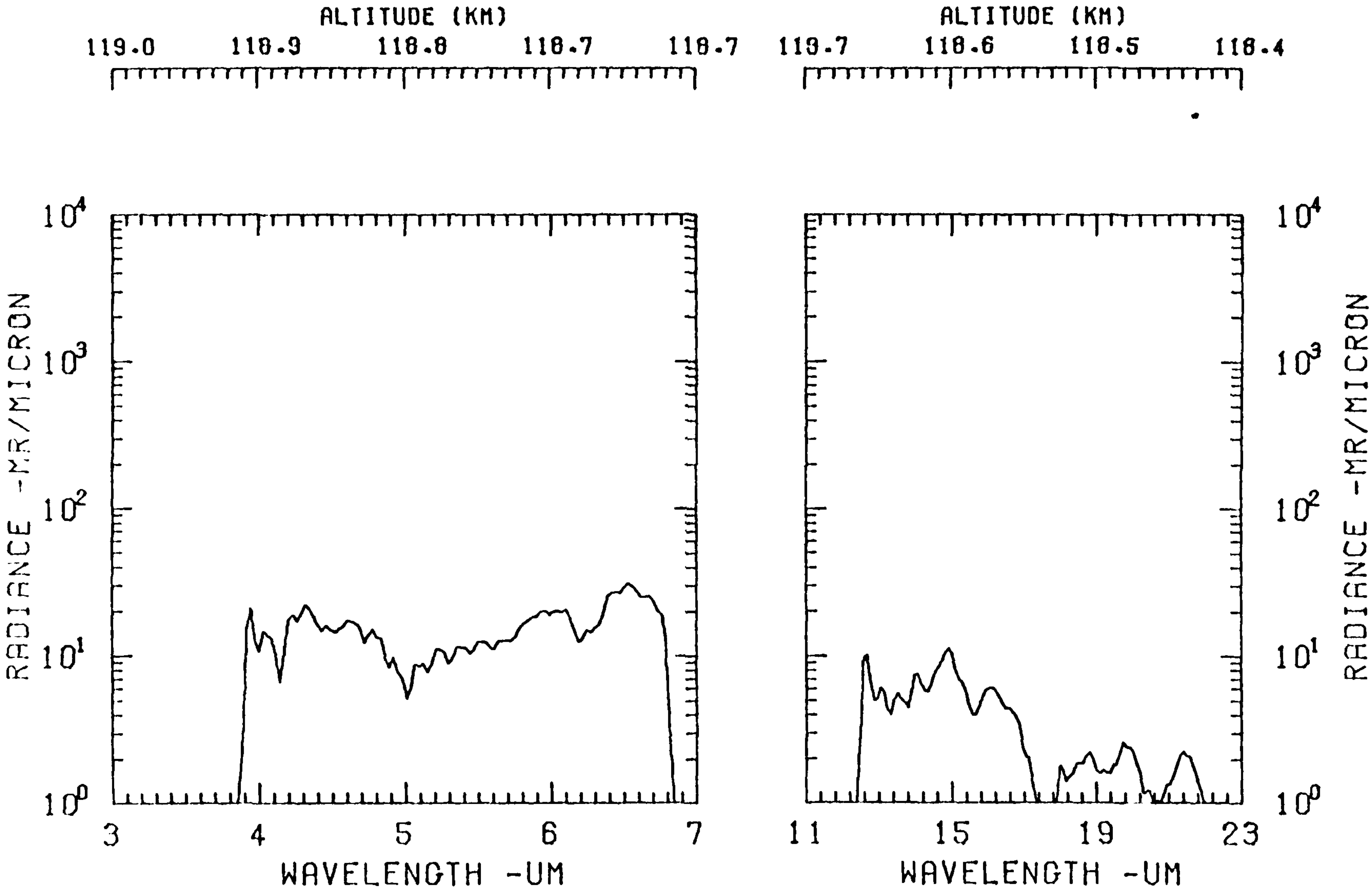
EXCEDE SPECTRAL SCAN 1095 TAL= 154.1 ALT= 123.2 ALL GAIN CAL. 53



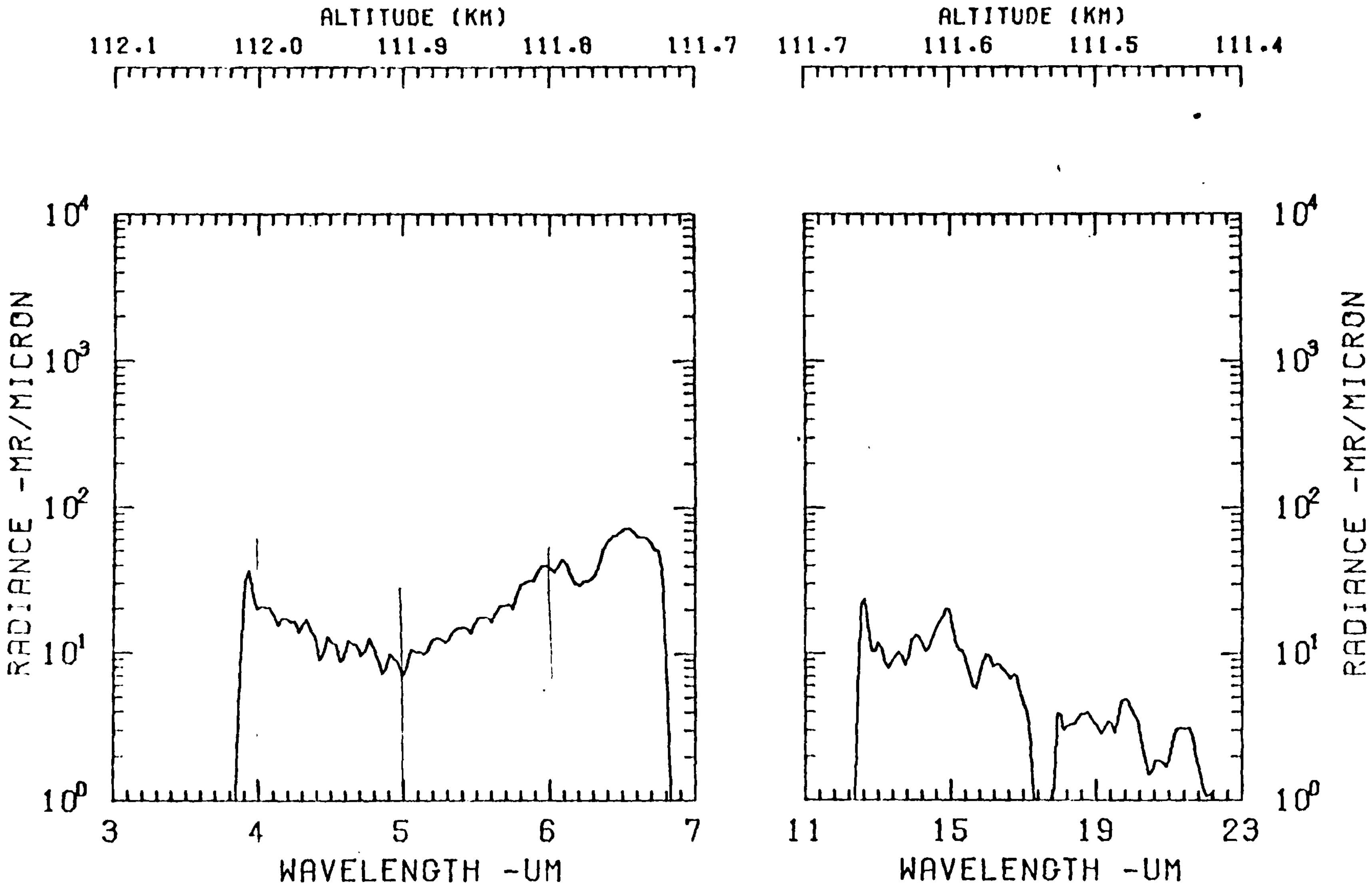
EXCEDE SPECTRAL SCAN 1109 TAL= 171.3 ALT= 127.3 ALL GAIN CAL. 53



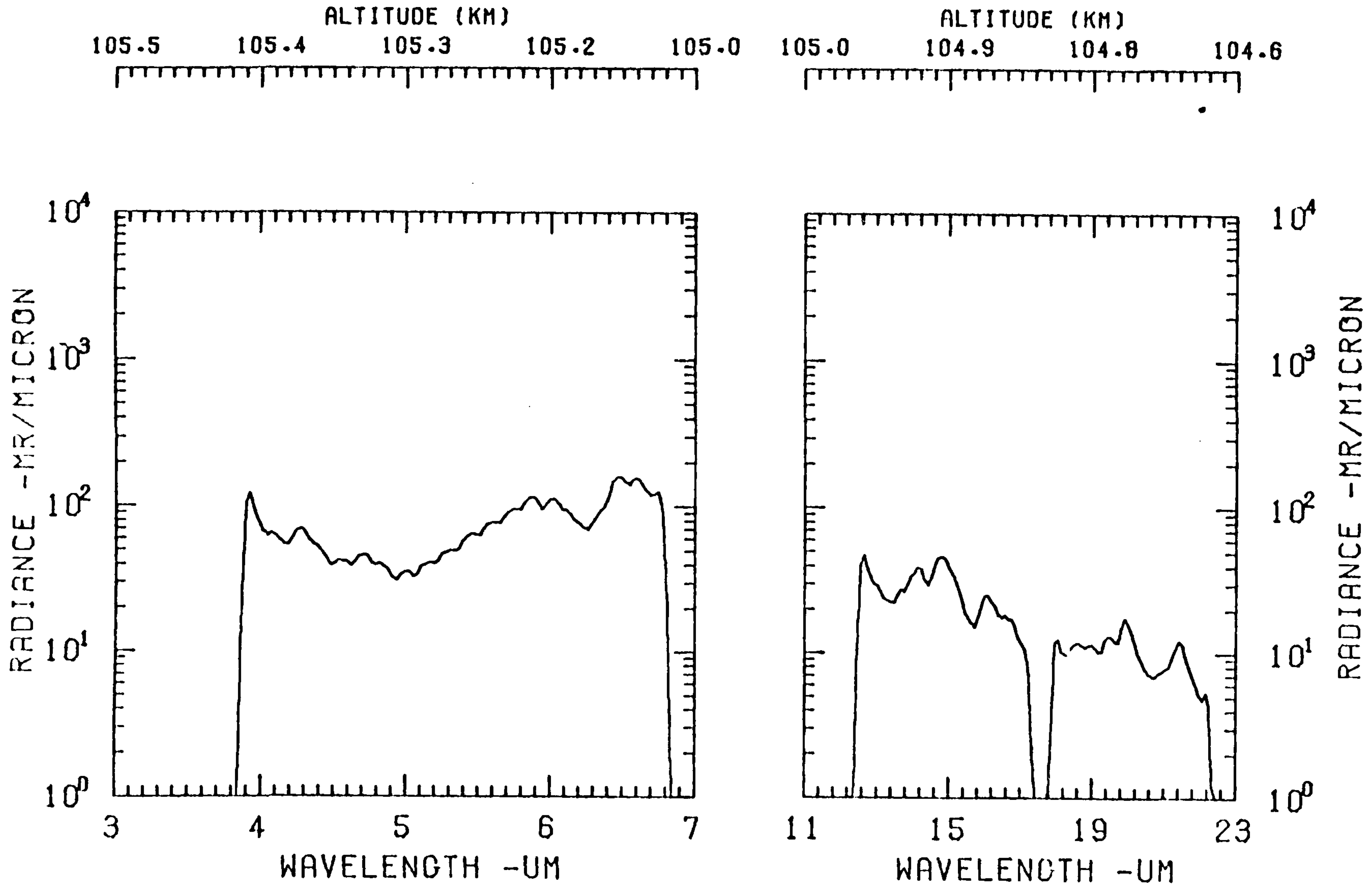
EXCEDE SPECTRAL SCAN 1111 TAL= 173.8 ALT= 127.6 ALL GAIN CAL. 53



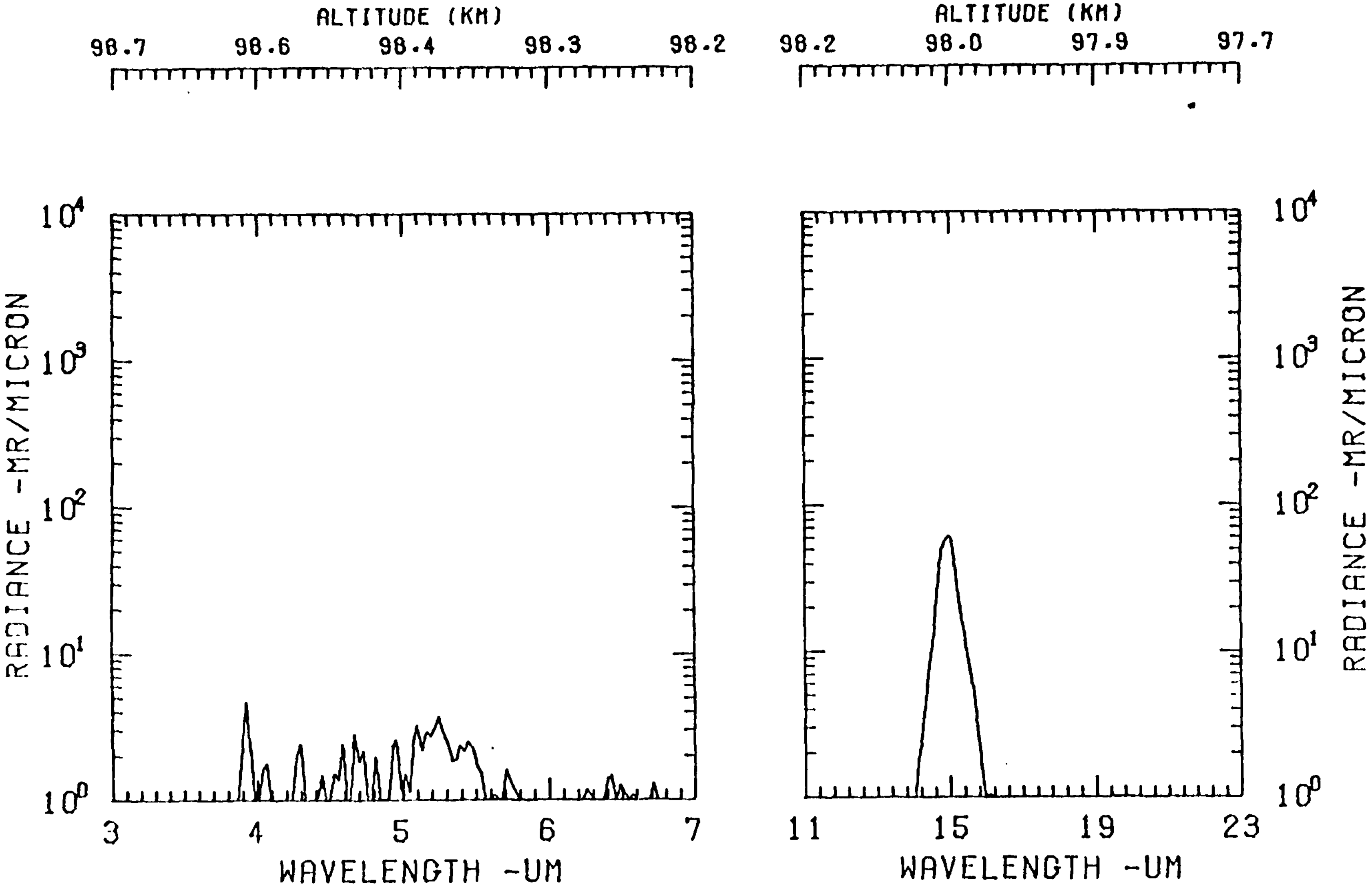
EXCEDE SPECTRAL SCAN 1159 TAL= 233.0 ALT= 118.9 ALL GAIN CAL. 53



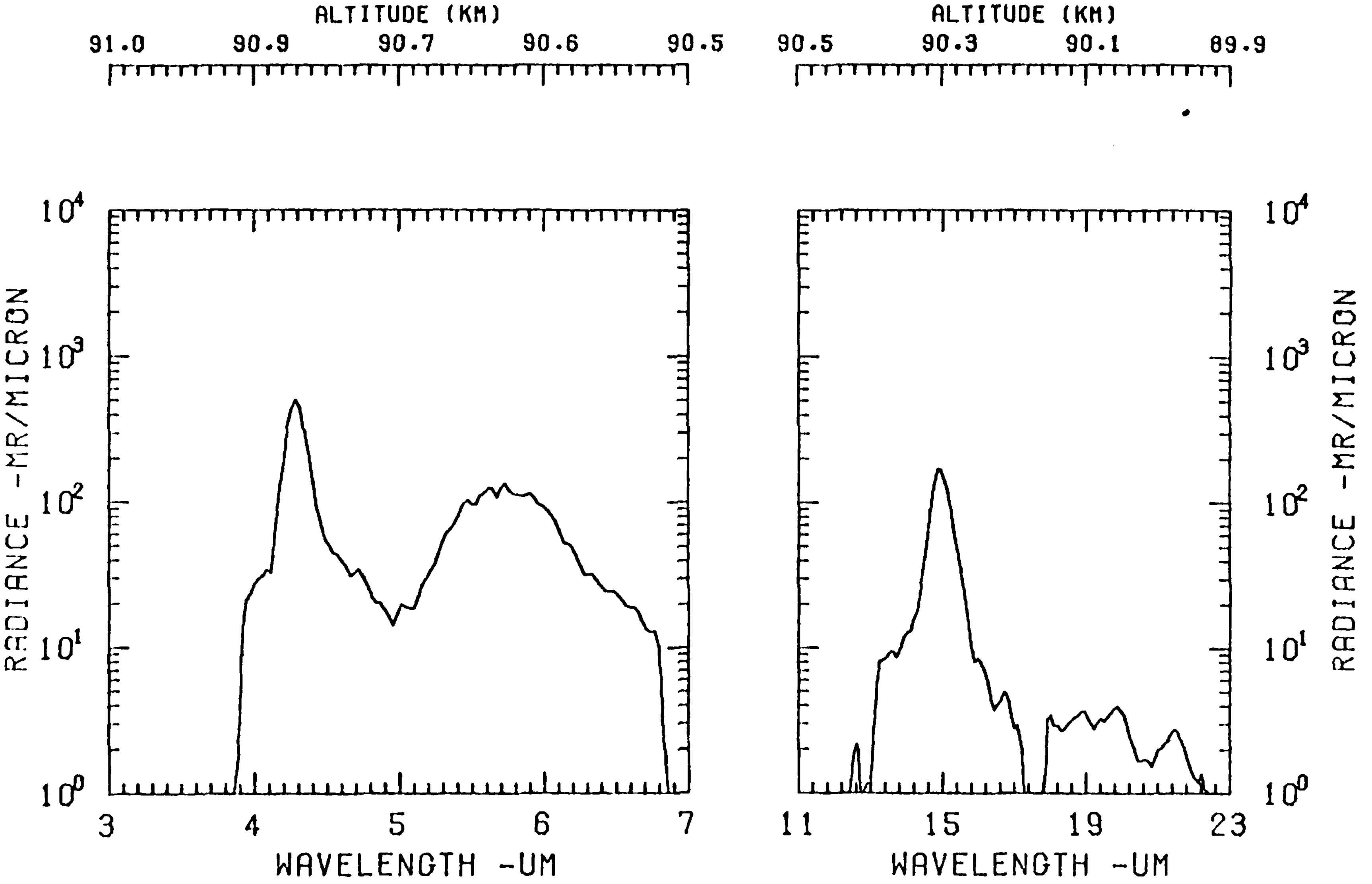
EXCEDE SPECTRAL SCAN 1171 TAL= 247.0 ALT= 112.0 ALL GAIN CAL. 53



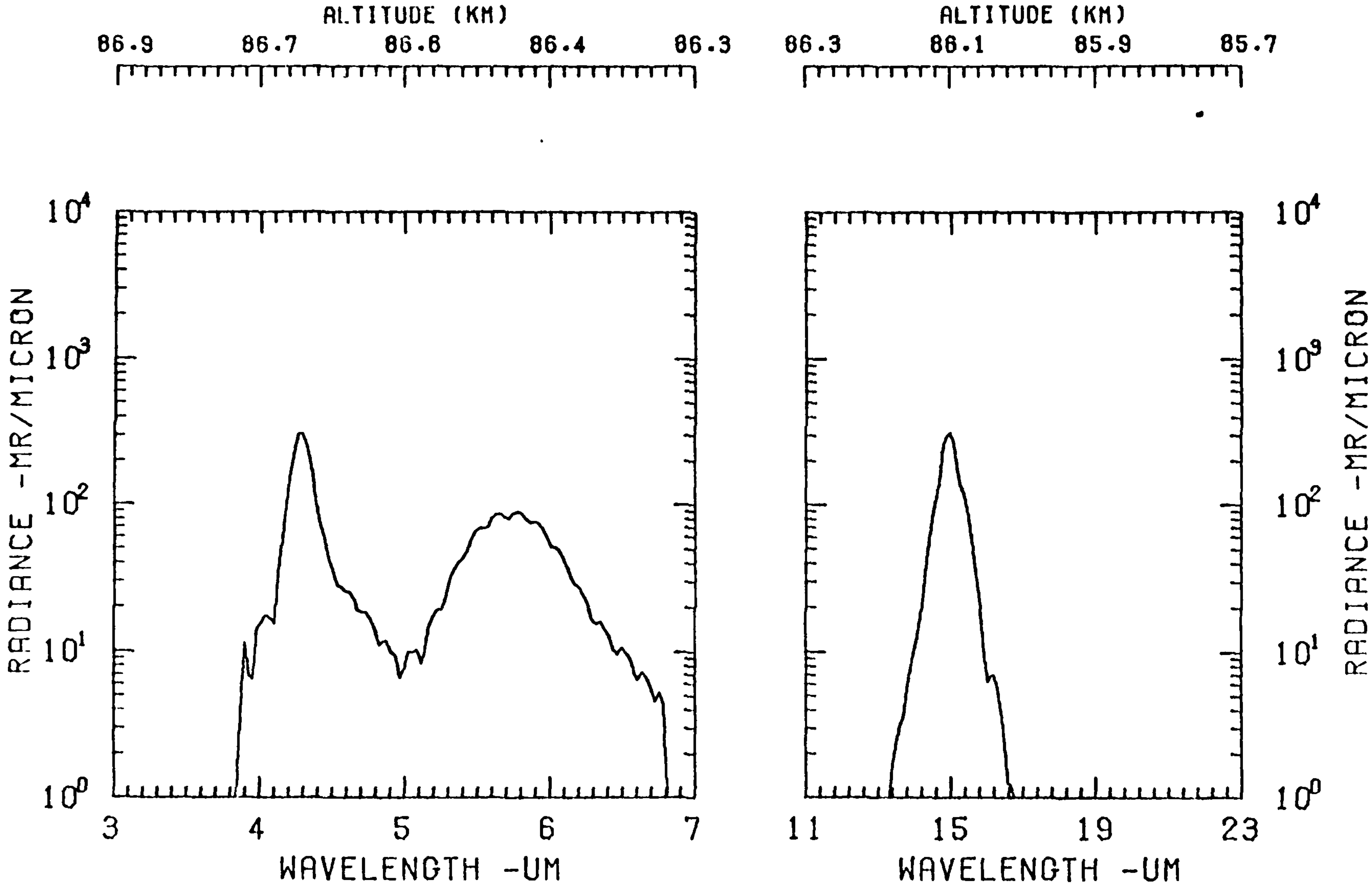
EXCEDE SPECTRAL SCAN 1180 TAL= 257.9 ALT= 105.4 ALL GAIN CAL. 53



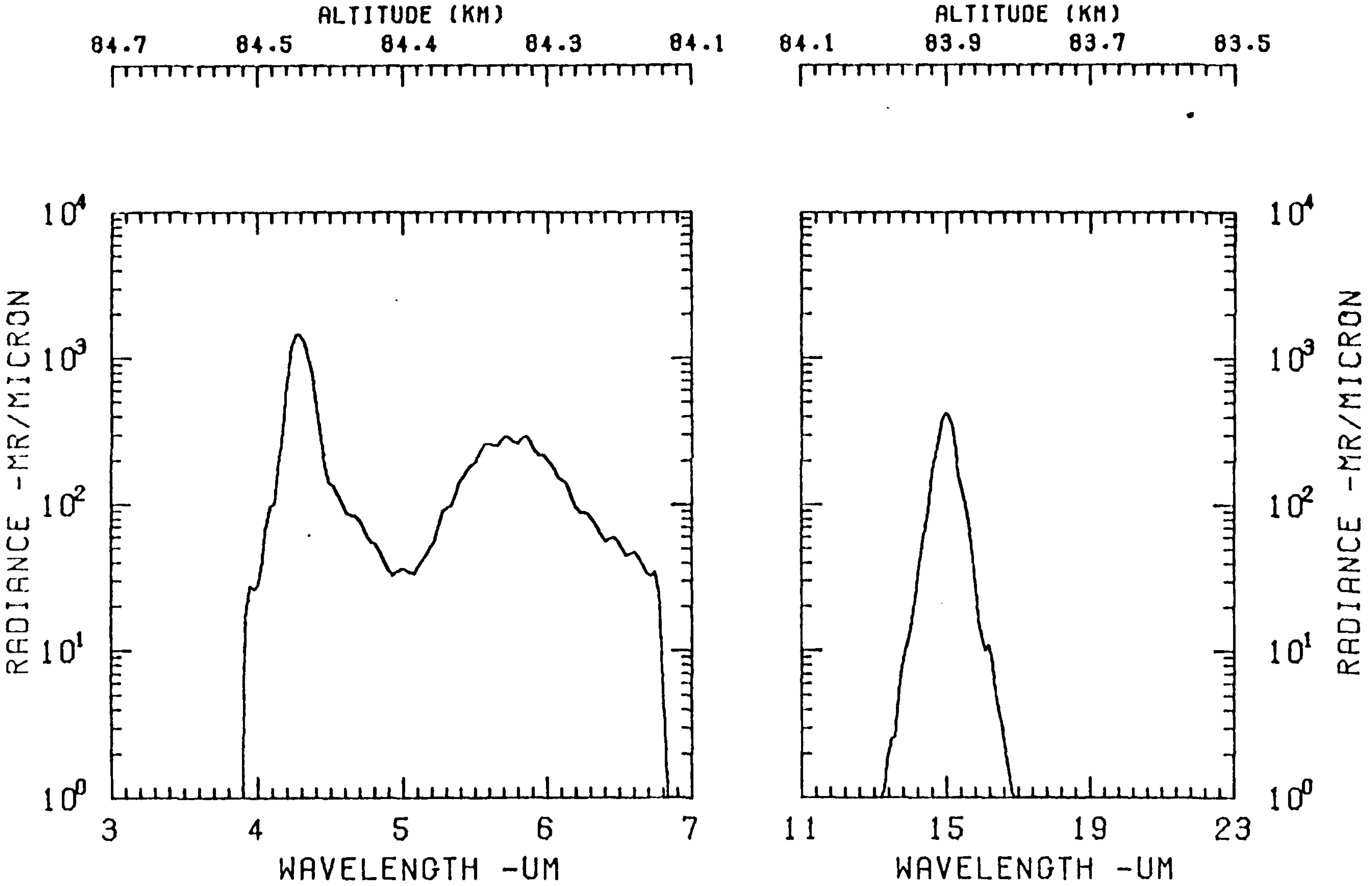
EXCEDE SPECTRAL SCAN 1188 TAL= 267.5 ALT= 98.6 ALL GAIN CAL. 53



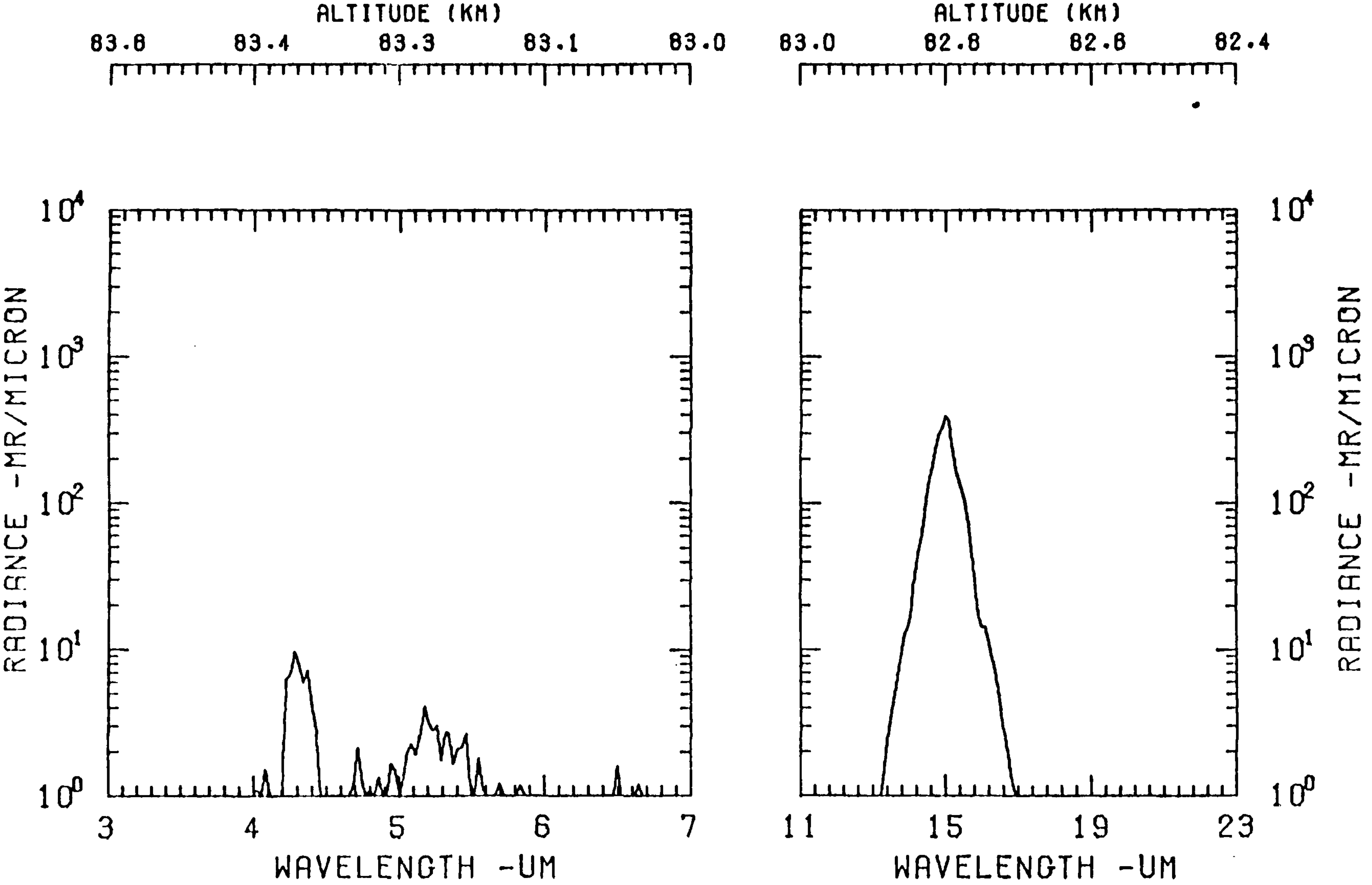
EXCEDE SPECTRAL SCAN 1196 TAL= 277.2 ALT= 91.0 ALL GAIN CAL. 53



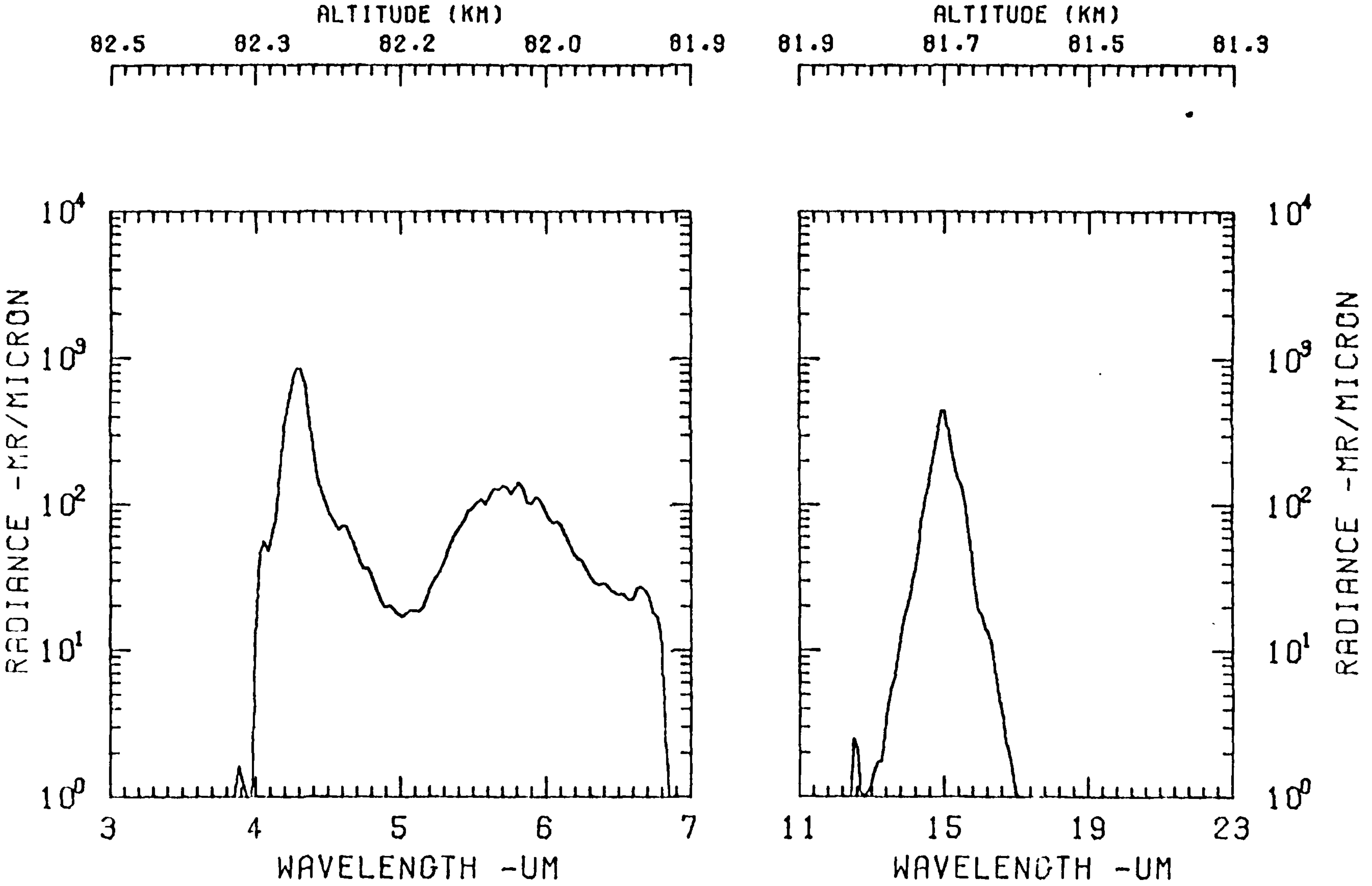
EXCEDE SPECTRAL SCAN 1200 TAL= 282.0 ALT= 86.8 ALL GAIN CAL. 53



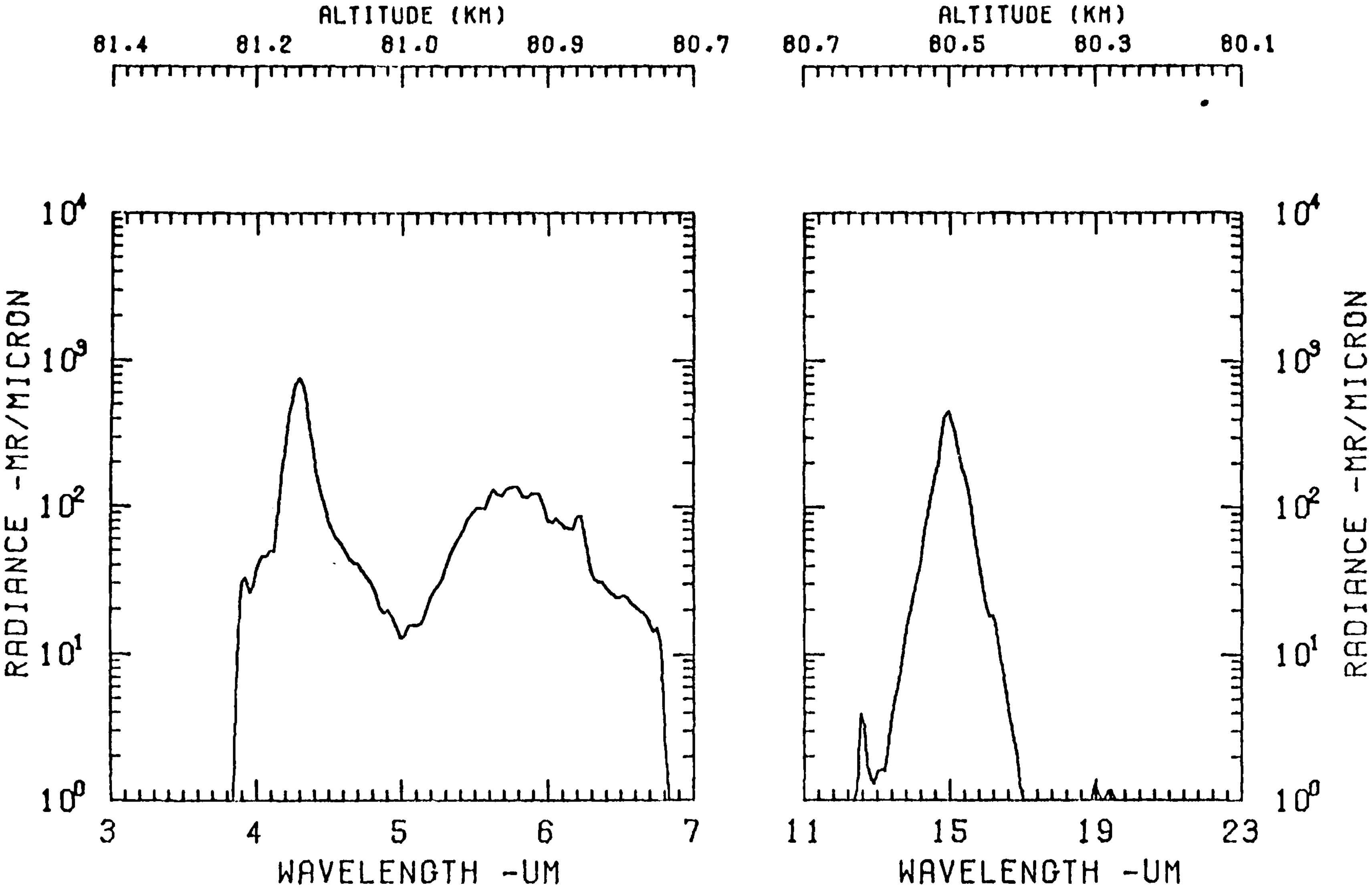
EXCEDE SPECTRAL SCAN 1202 TAL= 284.4 ALT= 84.6 ALL GAIN CAL. 53



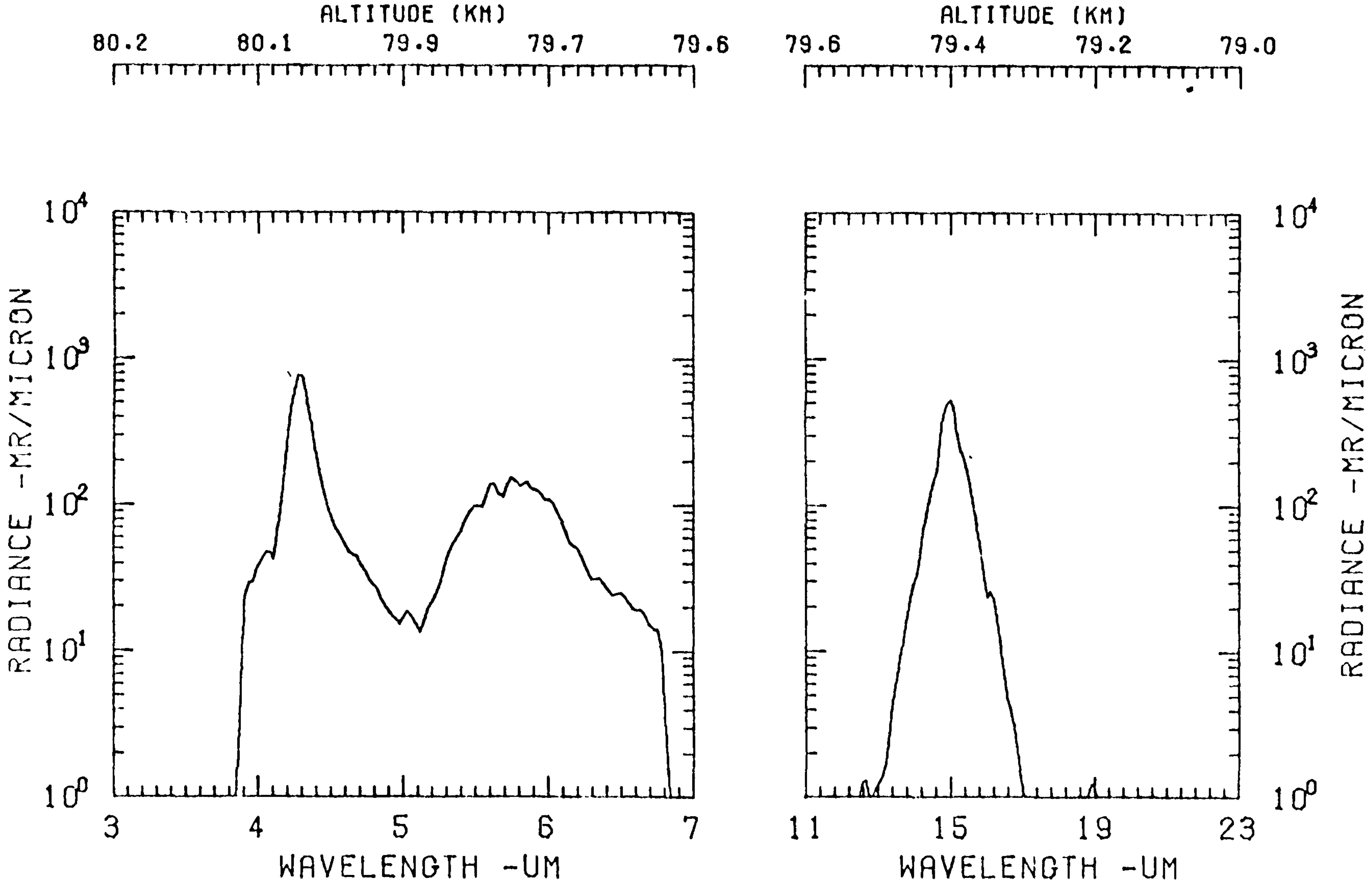
EXCEDE SPECTRAL SCAN 1203 TAL= 285.6 ALT= 83.5 ALL GAIN CAL. 53



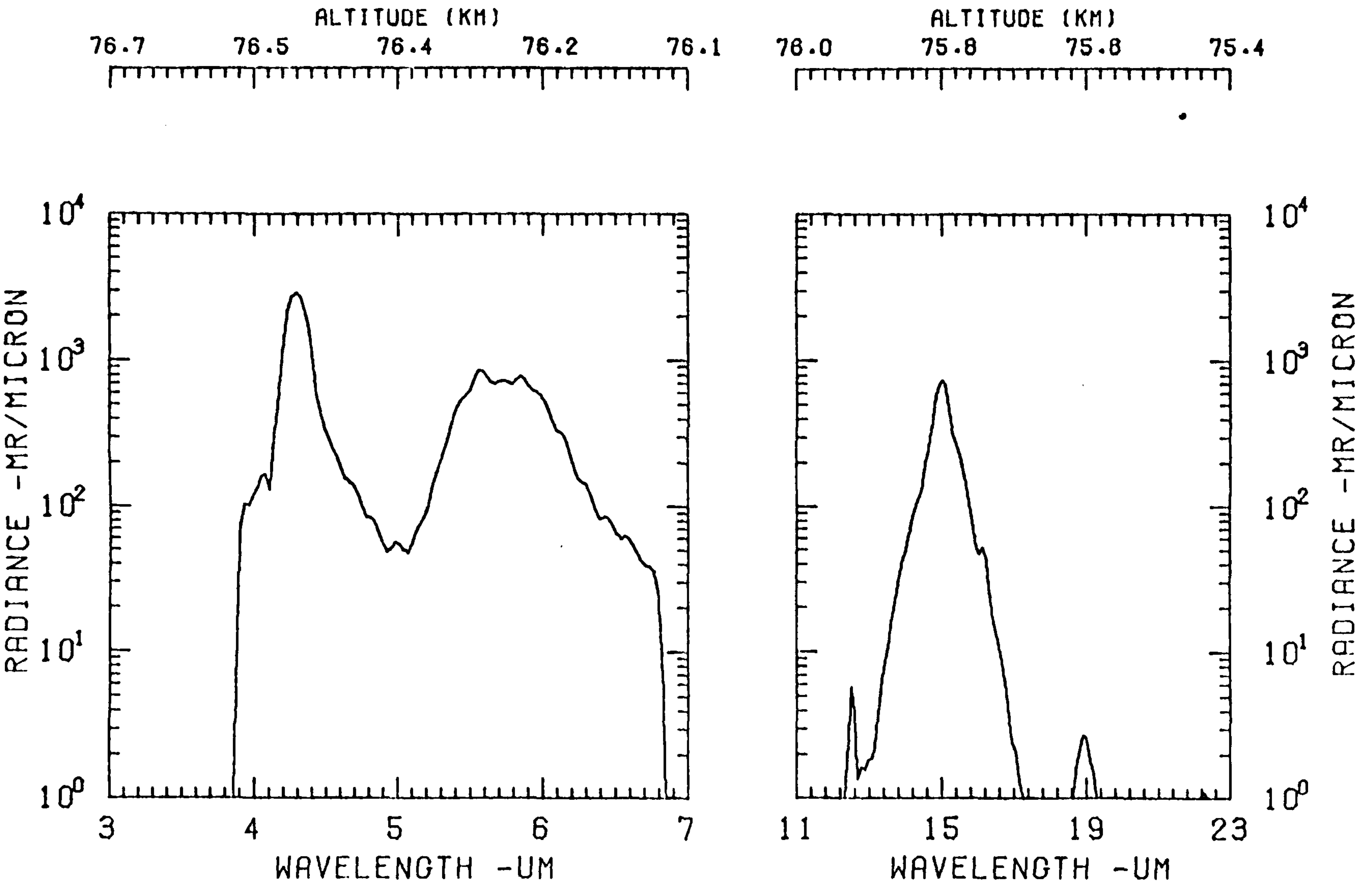
EXCEDE SPECTRAL SCAN 1204 TAL= 286.8 ALT= 82.4 ALL GAIN CAL. 53



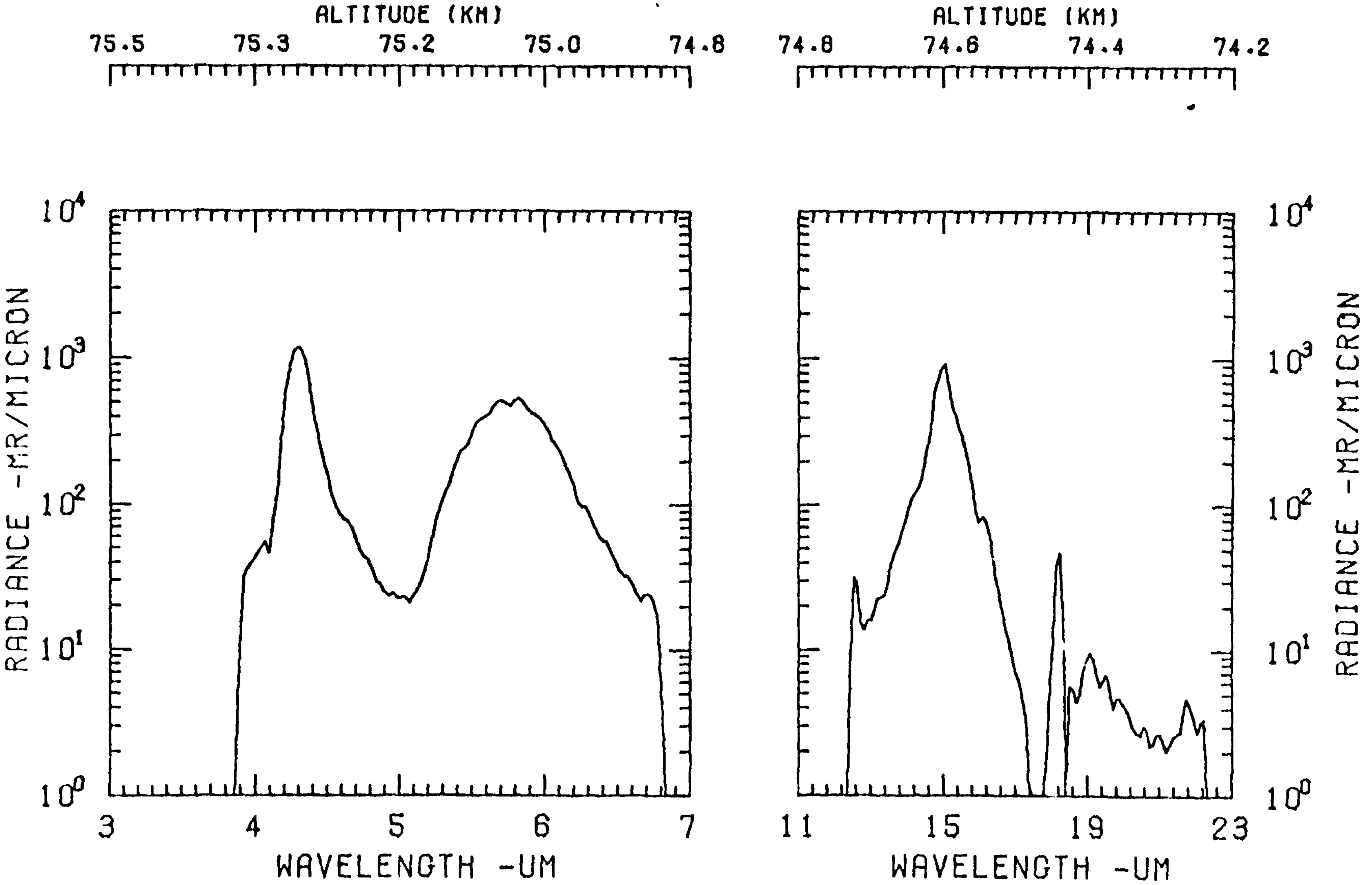
EXCEDE SPECTRAL SCAN 1205 TAL= 288.0 ALT= 81.3 ALL GAIN CAL. 53



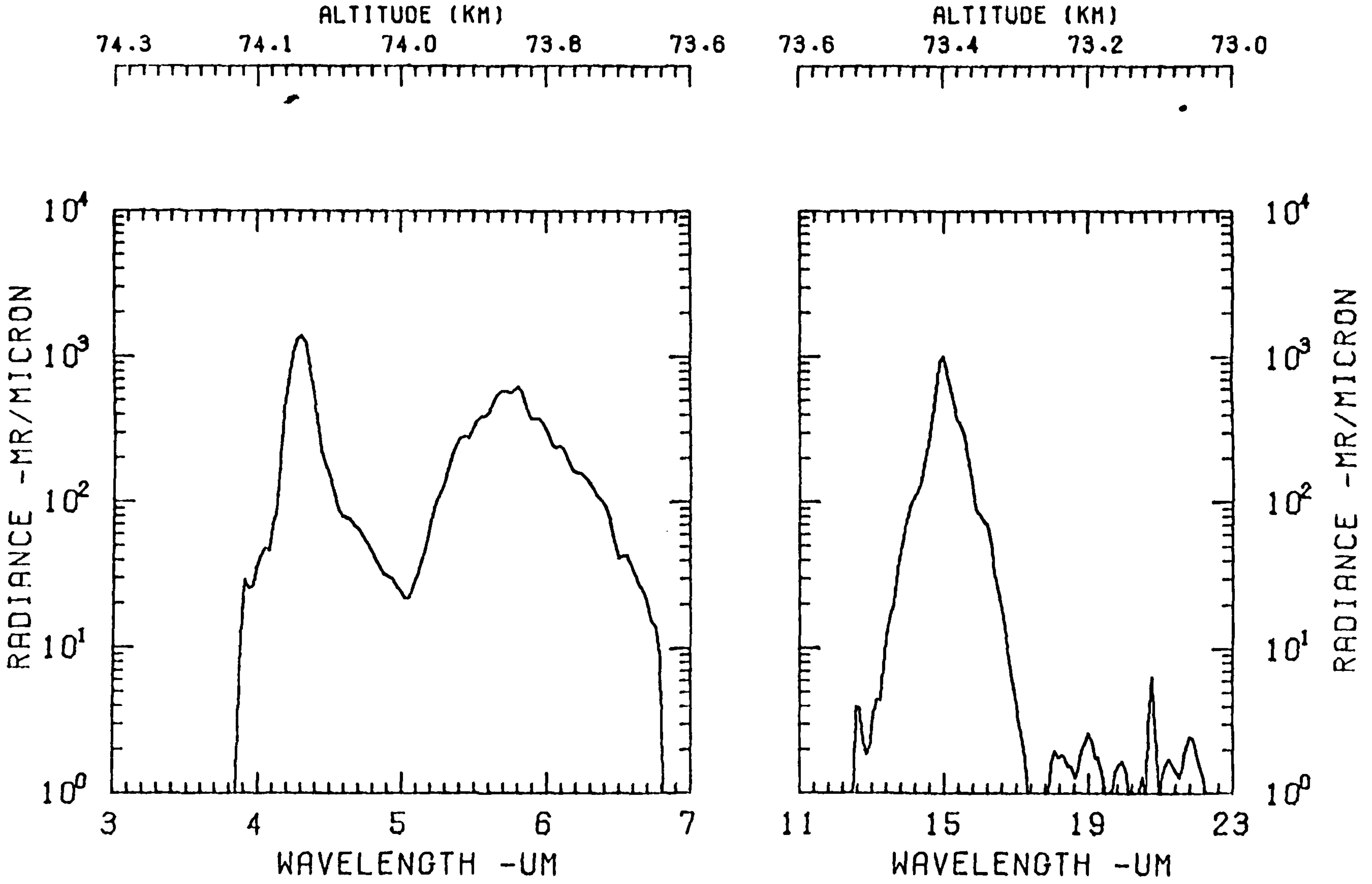
EXCEDE SPECTRAL SCAN 1206 TAL= 289.2 ALT= 80.2 ALL GAIN CAL. 53



EXCEDE SPECTRAL SCAN 1209 TAL= 292.8 ALT= 76.6 ALL GAIN CAL. 53



EXCEDE SPECTRAL SCAN 1210 TAL= 294.0 ALT= 75.4 ALL GAIN CAL. 53



EXCEDE SPECTRAL SCAN 1211 TAL= 295.3 ALT= 74.2 ALL GAIN CAL. 53

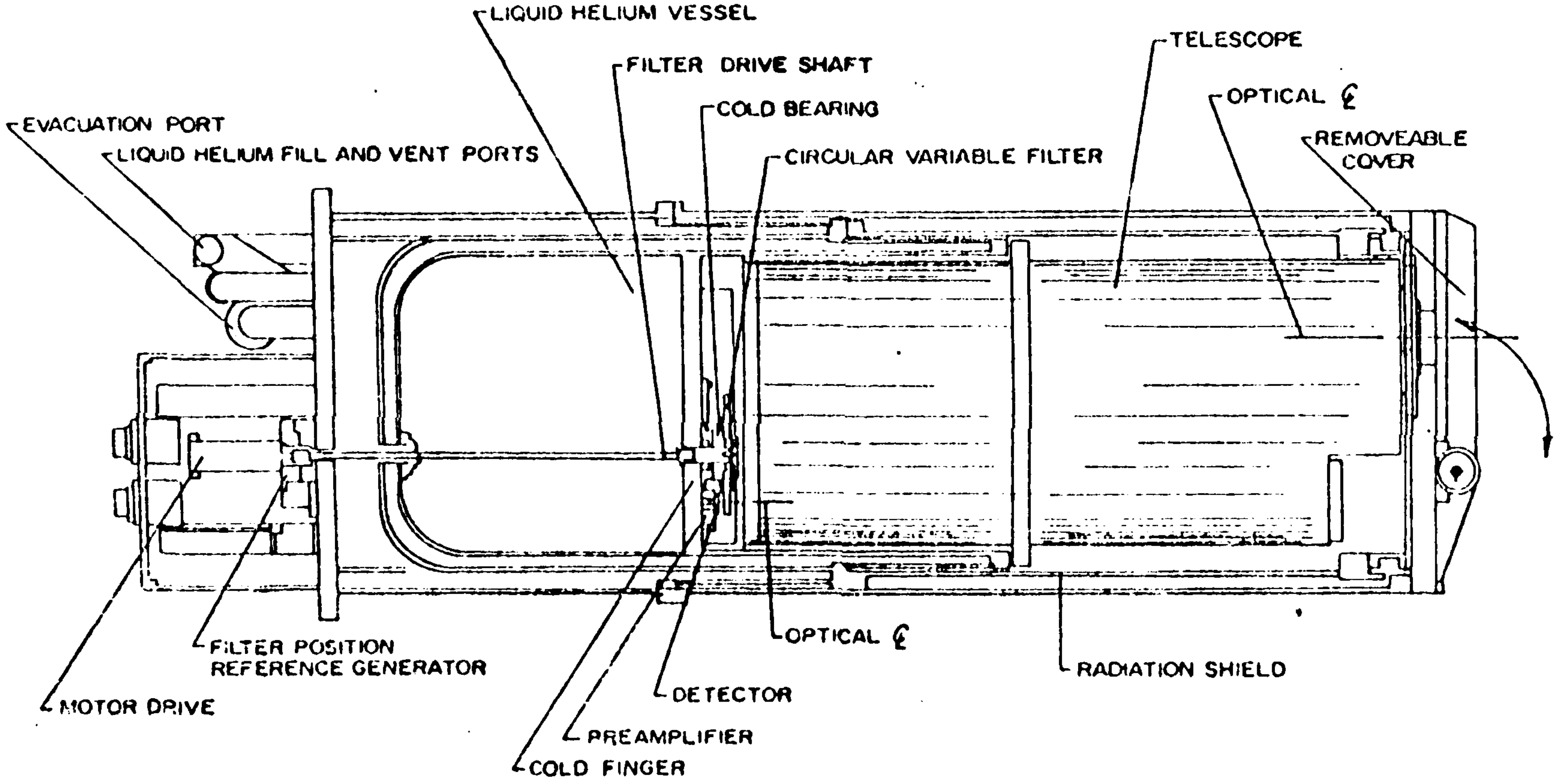

LIQUID HELIUM VESSEL
FILTER DRIVE SHAFT
COLD BEARING
CIRCULAR VARIABLE FILTER
TELESCOPE
OPTICAL ℄
REMOVEABLE COVER
EVACUATION PORT
LIQUID HELIUM FILL AND VENT PORTS
OPTICAL ℄
RADIATION SHIELD
FILTER POSITION REFERENCE GENERATOR
MOTOR DRIVE
DETECTOR
PREAMPLIFIER
COLD FINGER

Figure: 2.0-1 Schematic of a typical circular variable filter (CVF) spectrometer.

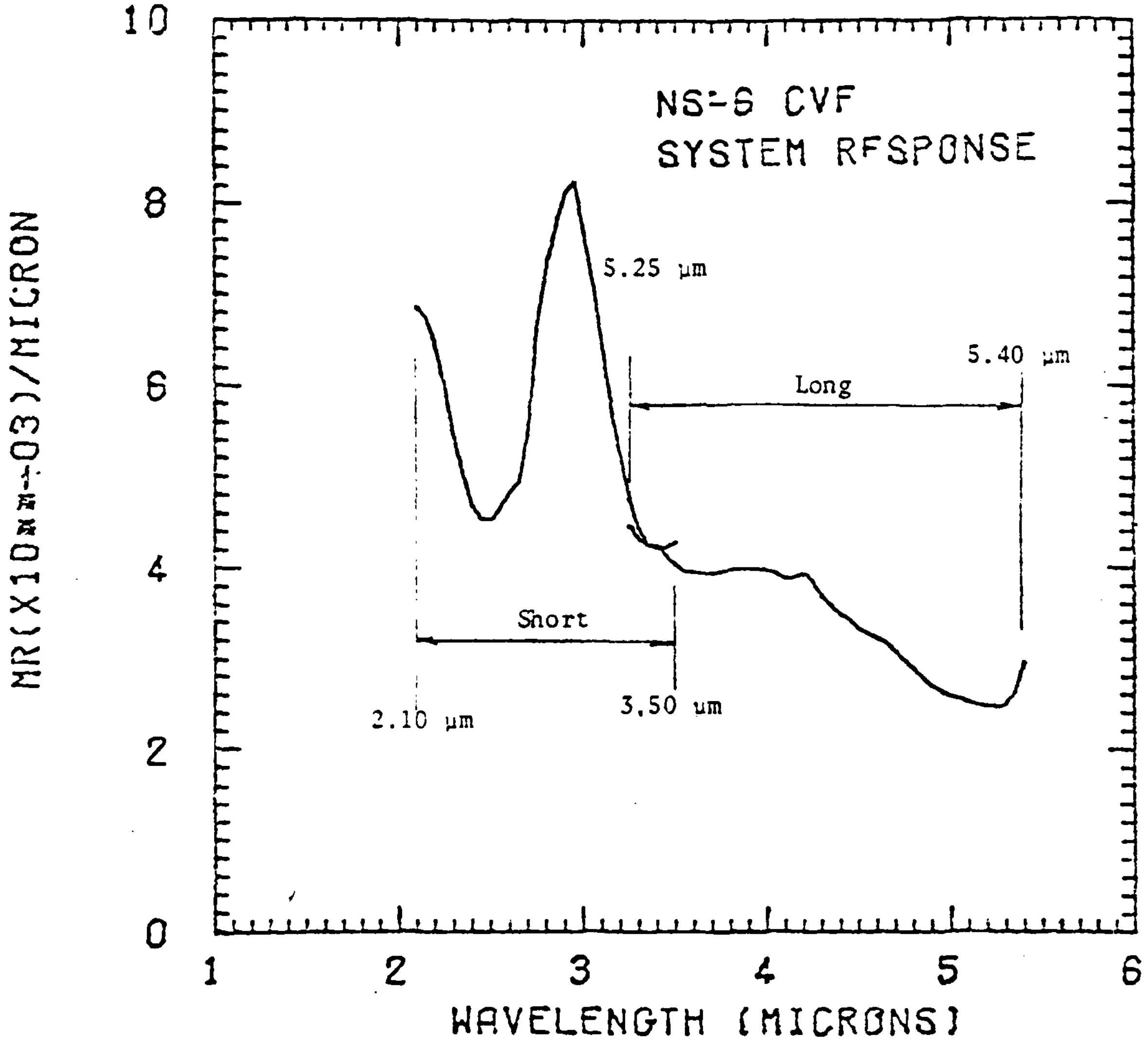


Figure 2.1-1. CVF brightness calibration (NS-6-4)

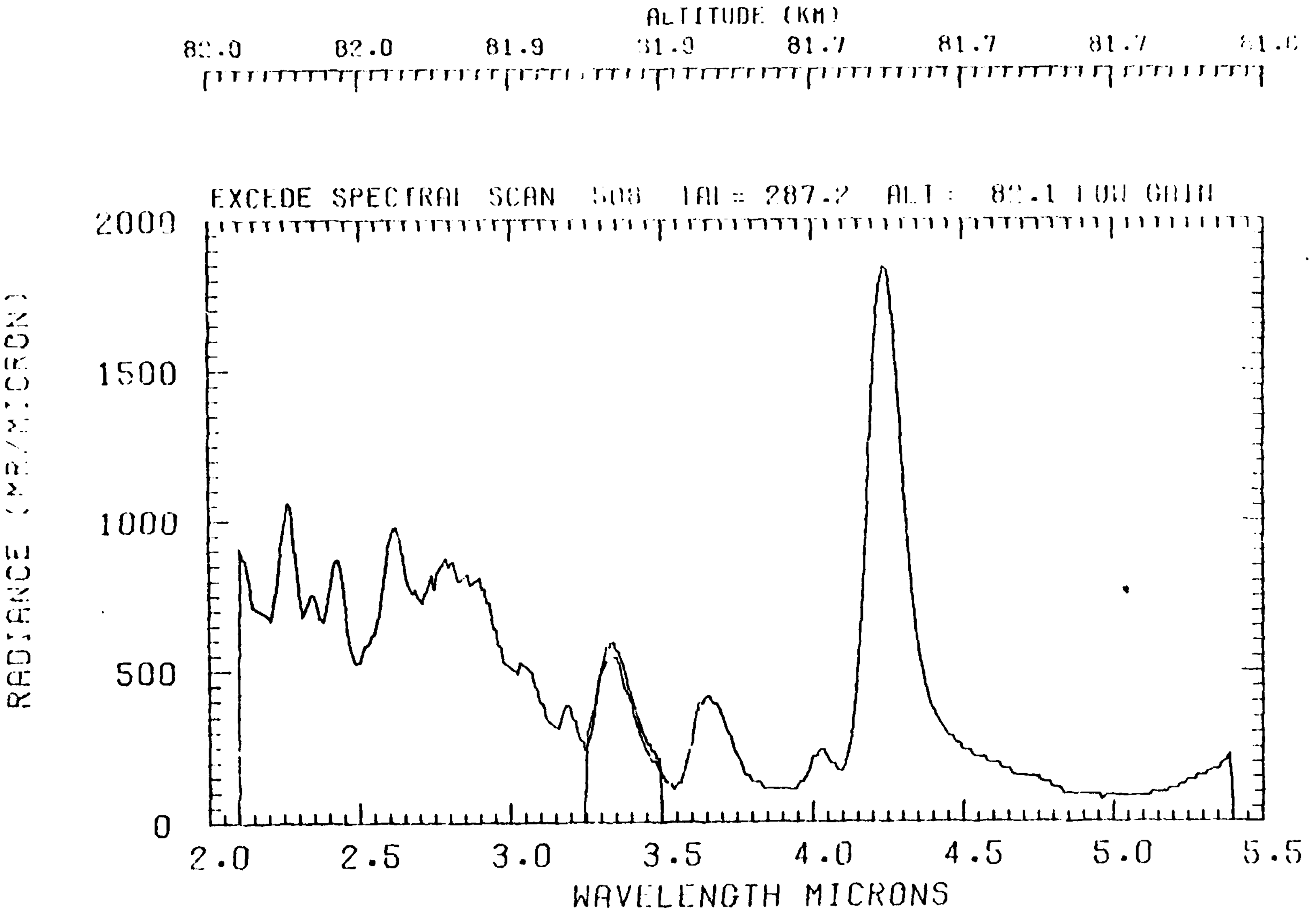


Figure 2.3-1. Sample spectra from EXCEDE short wavelength CVF spectrometer during electron gun operation.

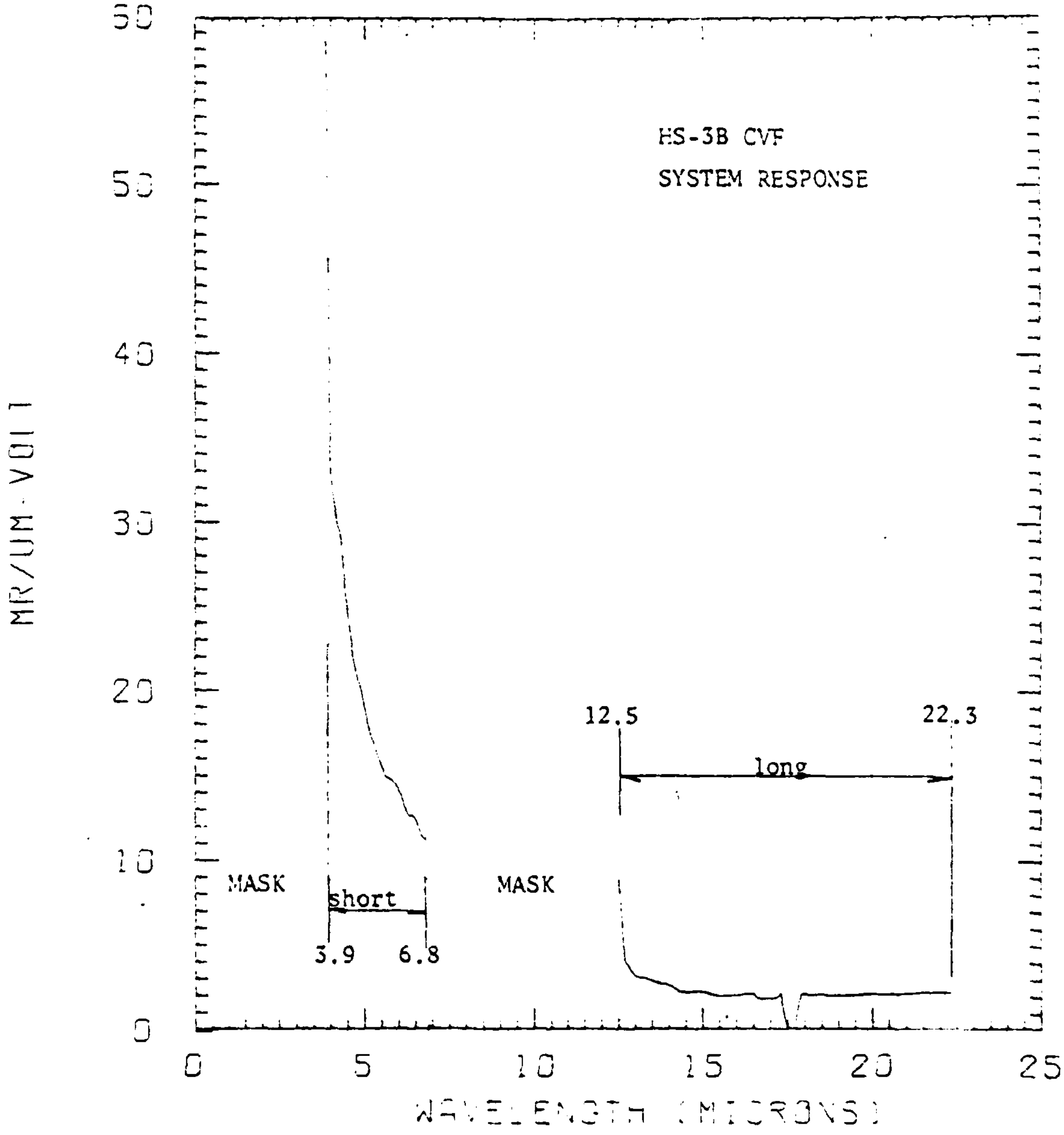


Figure 3.1-1 CVF Brightness Calibration (HS-3B-1)

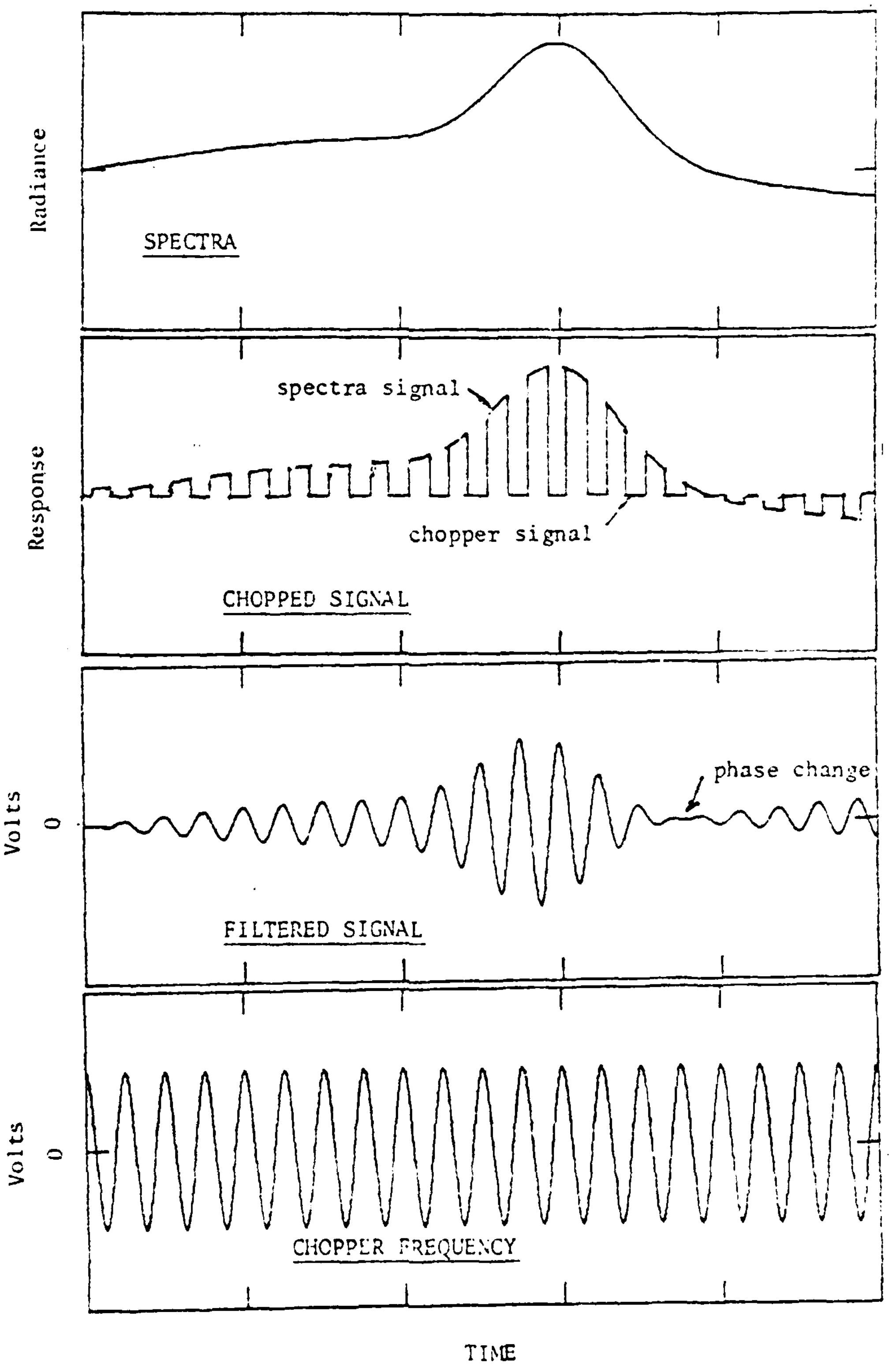


Figure 3.3-1. Principle of optically chopped CVF observation showing phase reversal when source radiance is less than copper radiance.

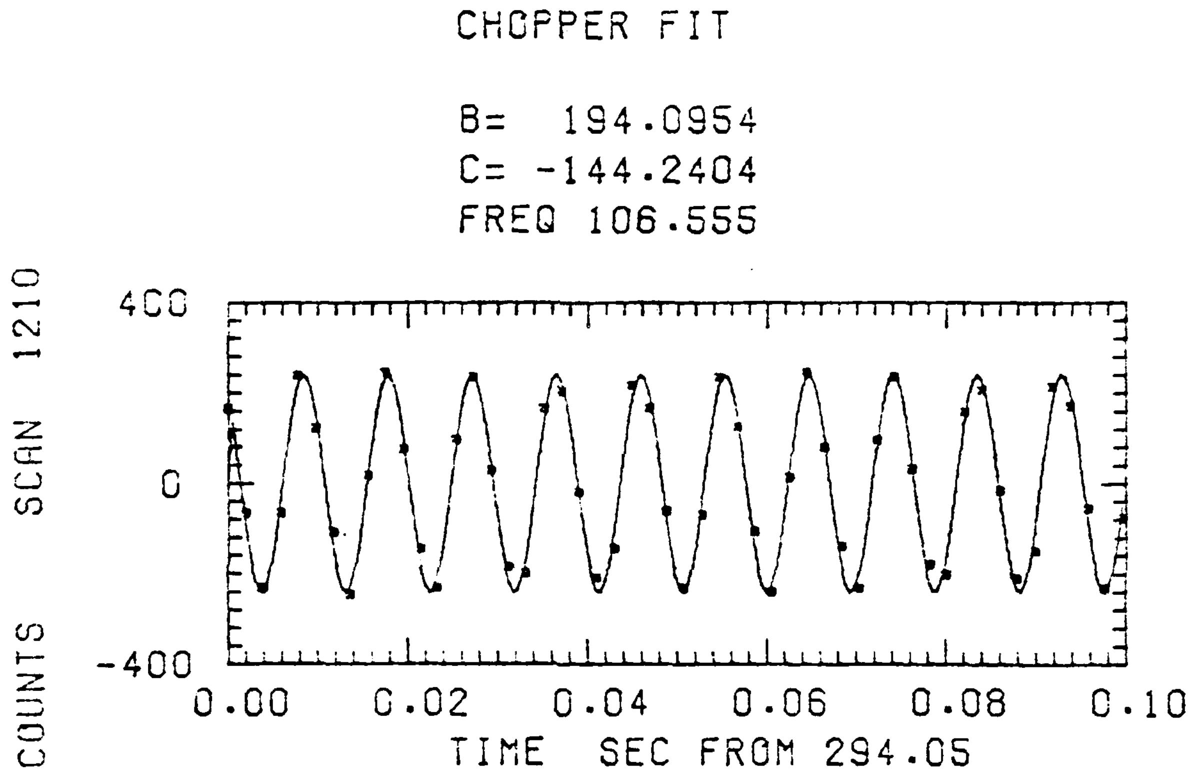
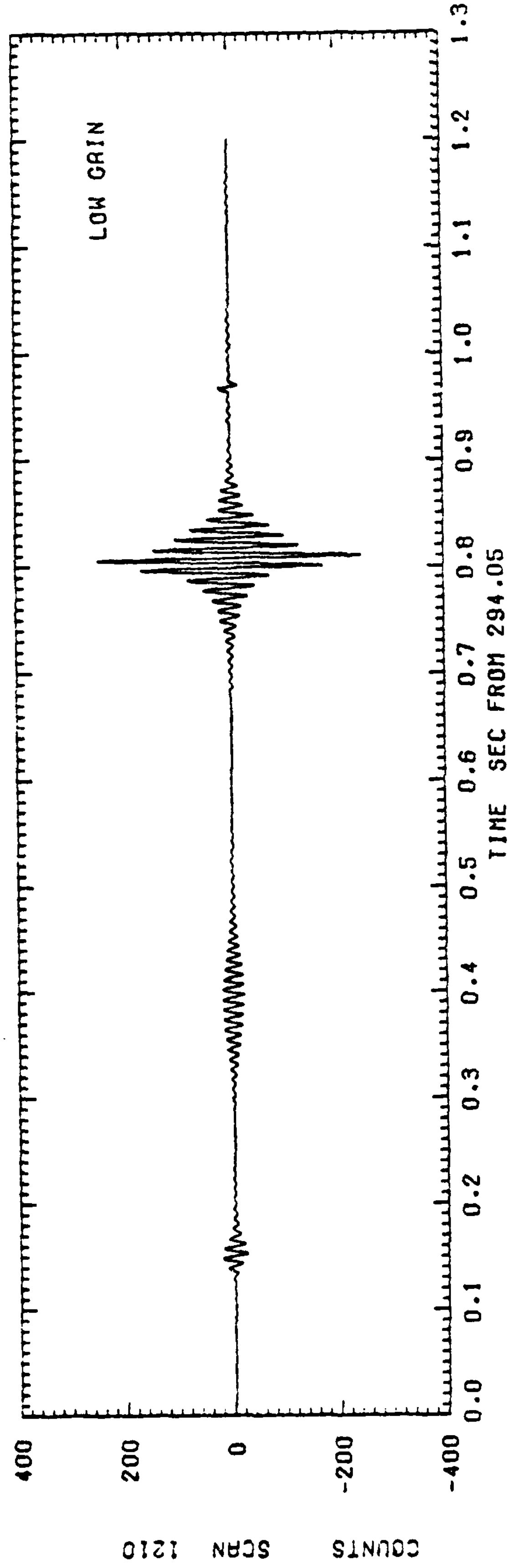


Figure 5.3-2. Example of least squares fit (sinusoid) to chopper signal (solid squares, for spectral scan 1210. Also shown are frequency and constants determined as a result of the best fit.


LOW GAIN
TIME SEC FROM 294.05
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
400
200
0
-200
-400
COUNTS SCAN 1210

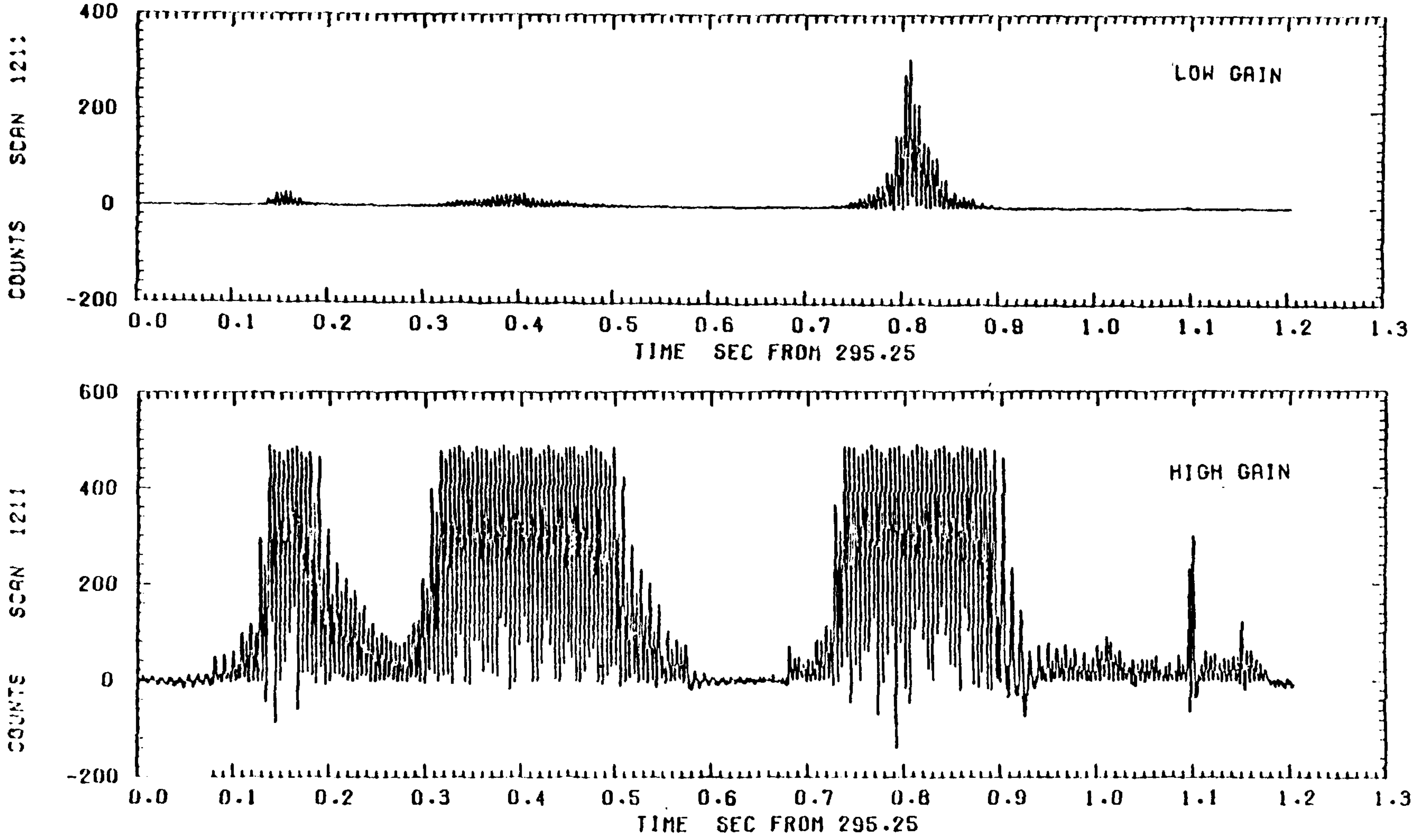

LOW GAIN
COUNTS SCAN 1211
400
200
0
-200
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
TIME SEC FROM 295.25
HIGH GAIN
COUNTS SCAN 1211
600
400
200
0
-200
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
TIME SEC FROM 295.25

Figure 3.3-3

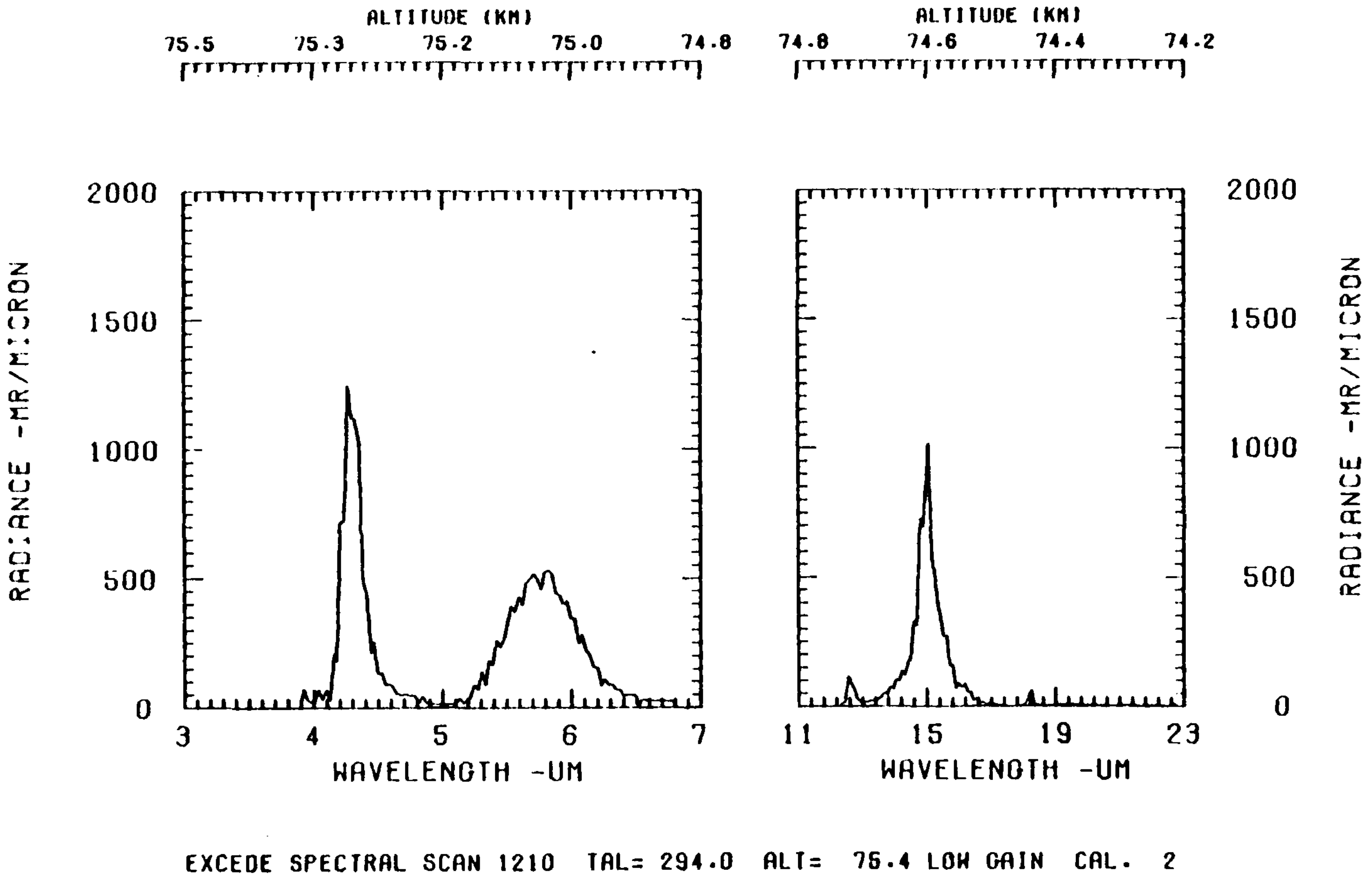


Figure 3.3-4 Example of unfiltered spectrum obtained with the EXCEDE chopped CVF.

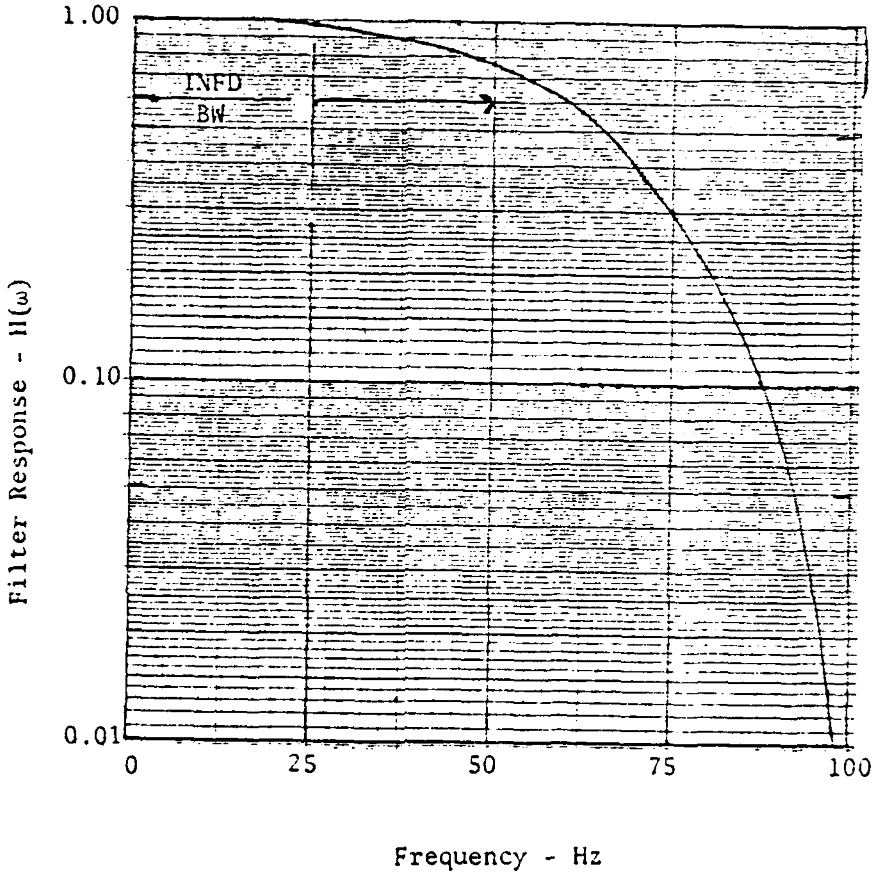


Figure 3.3-5. Frequency response of smoothing filter used after decimating data base to a sampling frequency of 205 Hz EXCEDE information bandwidth is 50 Hz.

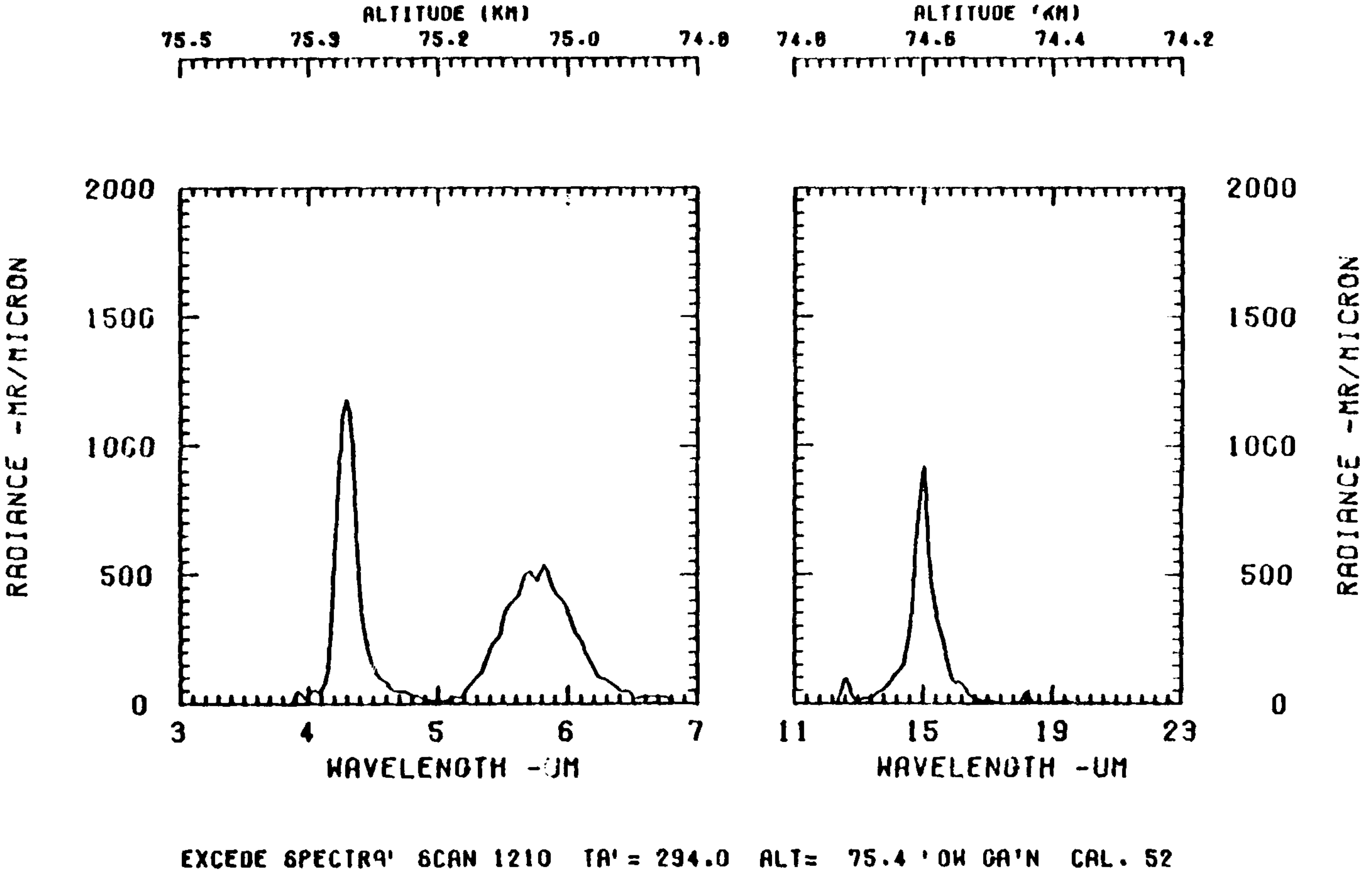


Figure 3.3-6 Example of smoothed spectrum using a 5 point smoothing filter.